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REINFORCED CONCRETE IN A CANADIAN MACHINE SHOP PLANT.

The accompanying view shows a notable application of reinforced concrete in the construction of a large machine shop recently completed in Toronto, Canada. The great amount of building and the consequent rise in price of brick has given a great impetus to the use of concrete for building purposes in Canada. In constructing the new plant of the Fairbanks-Morse Canadian Mfg. Co., on Bloor St., Toronto, concrete was used throughout. The plant covers about eight acres of ground, and comprises four main buildings. Of these the power-house has solid concrete walls 14 ins. thick. The other three buildings have reinforced concrete piers, with the space between filled by windows. The Kahn system of reinforcement was used in the foundry and in the other three buildings round bars were used bent into trusses in a manner similar to that employed in the Bush Terminal Company's Buildings in Brooklyn.

CENTRAL BAY OF MACHINE SHOP BUILDING BUILT OF REINFORCED CONCRETE FOR THE FAIRBANKS-MORSE CANADIAN MFG. CO., TORONTO, ONT.
(Showing Roof Girders of 53-Ft. Span.)

The ground where the buildings are located consists of gravelly clay, and the foundations were figured for a safe load on the soil of four tons per sq. ft. The footings were originally designed of reinforced concrete, but on account of opposition from the Building Department of Toronto, footings of plain concrete had to be substituted. The concrete in the foundation work was mixed in the proportion of 1-3-5, and elsewhere in the proportion of 1-2-4. Two concrete mixers were employed, one Ransome mixer driven by a steam engine, and one Smith mixer driven by a Fairbanks-Morse oil engine, both working satisfactorily throughout the job.

The most important of the buildings is the machine shop, which is 266 ft. long and 100 ft. wide, and contains a number of roof girders of more than 50-ft. clear span. This building contains two rows of interior columns spaced 51 ft. 6 in. from each other and about 24 ft. from the outside walls. The lower part of these columns, which support the electrically-driven crane, is 2 × 3 ft., and is reinforced with six 1-in. round bars tied together every 12 ins. with ⅛-in. wire. The upper part of the columns, which support the roof, is 2 ft. × 1 ft. 6 ins. and is reinforced with four ⅞-in. round rods, tied together every 12 ins. with ⅛-in. wire.

The central part of the building is about 34 ft. high and forms a shed for the crane, and on each side of this the building has a gallery floor about 15 ft. above the ground floor. The roof of these side parts is 27 ft. above the ground floor. The floors of the side galleries are of the "corrugated" type. A cross section is shown in Fig. 1.

The ribs are 33 ins. wide at the top and 6 ins. at the bottom and are reinforced with six 11-16-in. round bars. The ribs are spaced 3 ft. c. to c. for the gallery floor. The floor slab between the ribs is 3 ins. thick, reinforced with ¼-in. round bars, 6 ins. c. to c. The roof over the gallery floor is carried by ribs of the same dimension and with the same reinforcement as for the floor, but spaced 8 ft. c. to c. The roof slab is 3 ins. thick and reinforced with ¼-in. rods, 6 ins. c. to c.

The roof over the crane is carried by 34 concrete girders, spaced 8 ft. c. to c., with a span of 53 ft. These girders are 18 ins. wide, 3 ft. 10 ins. deep at the centre and 3 ft. 7 ins. at the ends, measuring from the top of the slab to the bottom of the girder. The bottom reinforcement consists of fifteen ⅞-in. round bars arranged in five rows of three each. The two upper ones in each row are bent up at the ends, but the lower ones run straight the entire length of the girder. Besides these tension rods, the girders contain five 1-in. round rods in the upper part of the girder. These 1-in. rods and the ⅞-in. rods are tied together with ¼-in. vertical stirrups to form five separate trusses.

The forms for the concrete work were made of 2-in. hemlock, the big girders being supported every 4 ft. by 6 × 6 in. posts. In one instance, the forms were removed from one of these 53-ft. girders when the concrete had been in place only two days.

The building laws of Toronto at the time this building was constructed required a safe compression stress in the concrete of 208 lbs. per sq. in., this figure also to apply to the extreme fiber stress in bending. No curtain walls were allowed with less thickness than 14 ins. These building laws have, however, lately been changed to conform to more modern practice.

The machine shop was commenced in September, 1905, and was completed in January, 1906. On account of an extremely mild winter, only a few days of freezing weather were encountered during the erection, and no concrete was laid during these few days.

The reinforced concrete work was designed by Mr. I. Kreuger, Assoc. M. Am. Soc. C. E., now Chief Engineer for the Consolidated Engineering & Construction Co., of Syracuse, N. Y. The contractor for the buildings was the Woodruff-Robins Co., of Toronto.

PRACTICAL HINTS FOR CONCRETE CONSTRUCTORS.*

By W. J. Douglas.†

I note in reading the engineering papers and other publications dealing with concrete construction that little is said about the general methods of design which govern first-class finished concrete work or the general methods necessary in the supervision of this class of work to attain satisfactory results. I hope that this article will be of sufficient interest to the readers of Engineering News to warrant them in discussing the subject of concrete along similar lines.

It is a lamentable fact that we do not succeed in getting as good results with finished concrete work as the French. The causes are various; they have been doing this class of work longer, use a better grade of mechanics and laborers, mix and place the concrete more carefully and study their designs more thoroughly, which re-

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sults not only in getting a better class of concrete work, but in their paying a higher price for it, that is, on a comparative basis. Frequently concrete work in this country is forced for its existence to compete with timber and steel, and to do this means frequently unreasonably high stresses and, what is even worse, that the contractor does not get enough money to do first-class work.

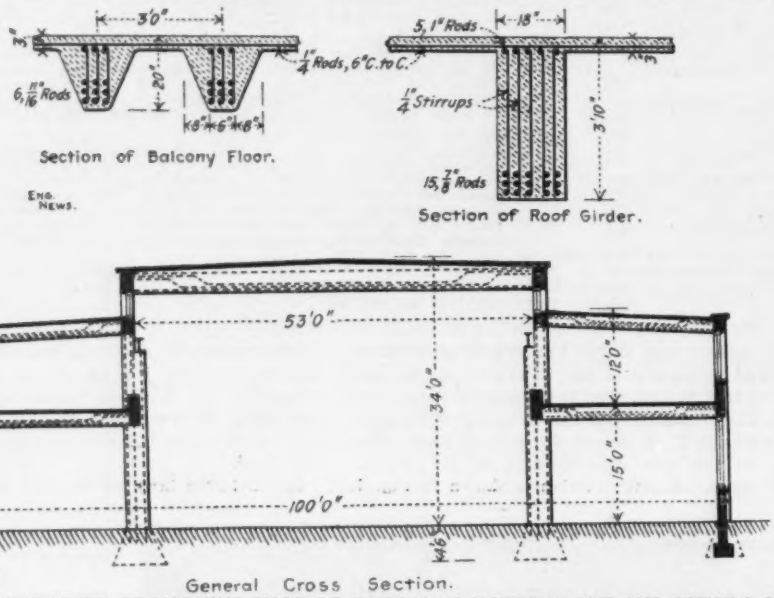


FIG. 1. CROSS-SECTION OF MACHINE SHOP OF FAIRBANKS-MORSE PLANT AND DETAILS OF GALLERY FLOOR AND ROOF GIRDERS OVER CENTRAL BAY.

In addition to this, we are handicapped by the fact that the concrete business has progressed at such a rapid rate that it is difficult to get competent engineers to design and supervise the work intelligently, and even more difficult to get experienced foremen, inspectors and mechanics to look after the detail execution. Our materials are often unexcelled. Where concrete has been used for foundations, backing or to replace heavy masonry for culverts, bridges, buildings and other structures in localities where its appearance has not been vital it has met with almost absolute success. But where appearance, in exposed places, has demanded care and experience the results have been more often unsatisfactory.

The work is, however, greatly improving, and it is a pleasure to note that after years of labor the profession has been able to practically obliterate the serious hair-cracks which marred their early structures. Probably the most important general item in finished concrete work which is now engaging the labors of concrete workers is that of overcoming the efflorescence which disfigures so many of our concrete structures. This question, however, is as yet unsolved.

Some Points in Detail Design.

The first thing that a concrete engineer has to do, after his general lines are laid out, is to select the general details of design. In this connection I have to call the attention of the inexperienced designer to the following, the greater part of which applies especially to bridge work:

The elastic theory as applied to concrete arches is very elegant and every concrete designer should be familiar with it, but in all cases except in that of very flat reinforced arches the common theory, intelligently applied, is all that is necessary. In the design of the Piney Branch bridge, now under construction in Washington, both theories were applied and the maximum pressures differed under the two analyses by only 5 lbs. per sq. in.

Don't spend much time worrying about the exact position of the neutral axis of a beam. After you have inspected work under construction for a time you will be convinced that the way concrete goes into the work does not permit of any hair-splitting application of theory.

Don't stress your concrete in compression higher than 300 lbs. per sq. in. (mixture 1:2:3:) in beams, columns or arch-work, unless you are going to have first-class inspection; 400 lbs. per sq. in. is high enough when the work is going to receive the best class of inspection. It is true that the French use very much higher stresses in their work, but they do a better class of work than we are at present doing in this country.

Select a design which gives little tension or shear where possible. Remember that concrete is strong in compression and weak otherwise. The parabola catenary and circle are the best curves for a concrete arch. Arches designed on these lines require little steel reinforcement. Elliptical arches and basket handles and other flat arches must be heavily reinforced with steel and should not be used unless the waterway or grade demand it. Very flat arches act more like beams than arches, in spite of the elastic theory.

STEEL REINFORCEMENT.—It is easier to design concrete work by using steel reinforcement than otherwise. The designer does not have to study his work as carefully in order to make sure that the concrete will not be subjected to tension or shear. When in doubt, reinforce with steel, as it is an axiomatic fact that in all cases it strengthens the work. Steel is particularly useful for beams, flat arches and structures whose foundations are poor (in order to allow for deformation) and for reinforcing the foundations.

Concrete cannot be safely used as a be[illegible] without reinforcement except by using absur[illegible] depths. Frequently it will be found in figuring [illegible]ut the cost of designs that unreinforced concret[illegible] will be cheaper than reinforced concrete on the [illegible]sis of the same factors of safety because of t[illegible] additional expense required in reinforced w[illegible]k for forming steel and the additional cost of [illegible]acing concrete in narrow forms. In one piece [illegible] work under my supervision which consists [illegible] very small ornamental reinforced houses, the [illegible]ctual cost was almost as much as it would ha[illegible] been for cut granite.

Bars having a mechanical bond are s[illegible]onger than plain rods, particularly in work wi[illegible] the inspection is not the best. Bars having [illegible] mechanical bond are particularly desirable [illegible] vertical and approximately vertical reinfor[illegible]ent, because in these positions they are fre[illegible]ently struck by the laborers and mechanics ha[illegible]dling material on the work and not infrequen[illegible]y by the concrete buckets. When bars are so [illegible]truck they lose their adhesion to the abutting co[illegible]rete, if it is partially set up. This loss of adhes[illegible]n, in bars of an inch thickness, will extend do[illegible]n as far as 18 ins. from the top surface of the concrete. This is one of the many reasons why light reinforcement (small bars in a larger numb[illegible]r) is better than heavy reinforcement. When the adhesion is broken, you are forced to rely o[illegible] the mechanical bond. Rods should not be placed closer to corners or other face work than three diameters. It is not uncommon, where the reinforcement is closer, that the concrete on the outside of the rods (particularly where the reinforcement is vertical) will spall off. Small mesh reinforcement must not be used where the aggregate is large, as it is difficult to force the concrete through the mesh so as to completely encase it. It is well in design to keep in mind in a general way the practicability of holding reinforcement in place during the concreting. Reinforce all thin walls, particularly at their junction with other work—and amply, as they are easily thrown into tension. Do not put in an absurdly small quantity of steel in a large structure, as it has no motive.

A great deal of money can be saved in the design by using leaner mixtures in foundation and mass work than is common practice. It is not uncommon to see a 1-2-5 mixture which would safely carry a load of 20 tons used in a large foundation where the supporting clay will only carry a couple of tons per sq. ft. Of course, in using lean mixtures it requires better mixing and better supervision.

Where first-class foundation soil cannot be economically reached, use reinforcement in the

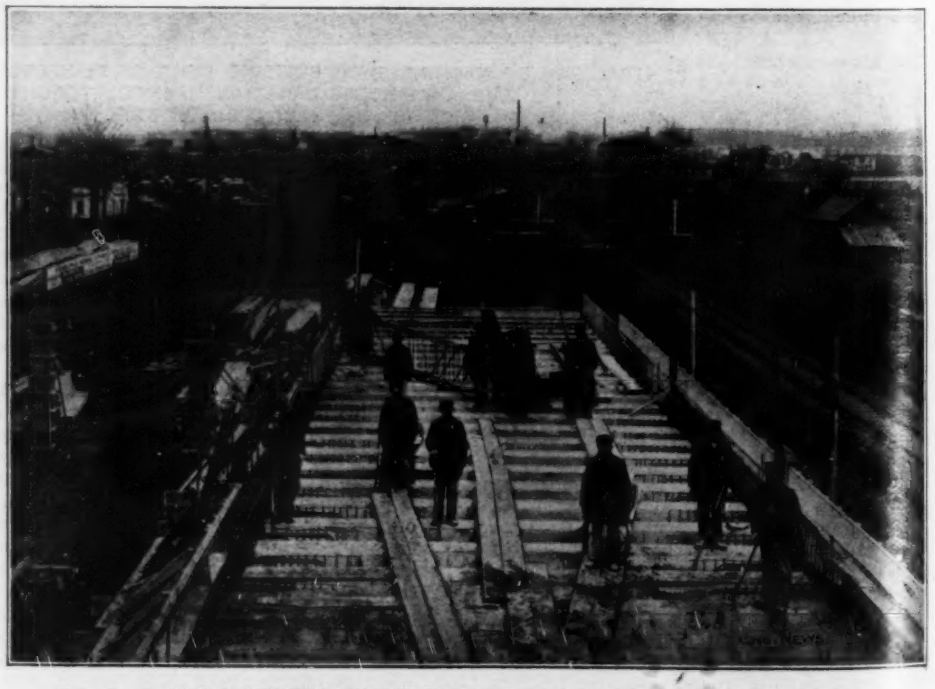


FIG. 2. PLACING REINFORCEMENT FOR GALLERY FLOOR OF MACHINE SHOP.

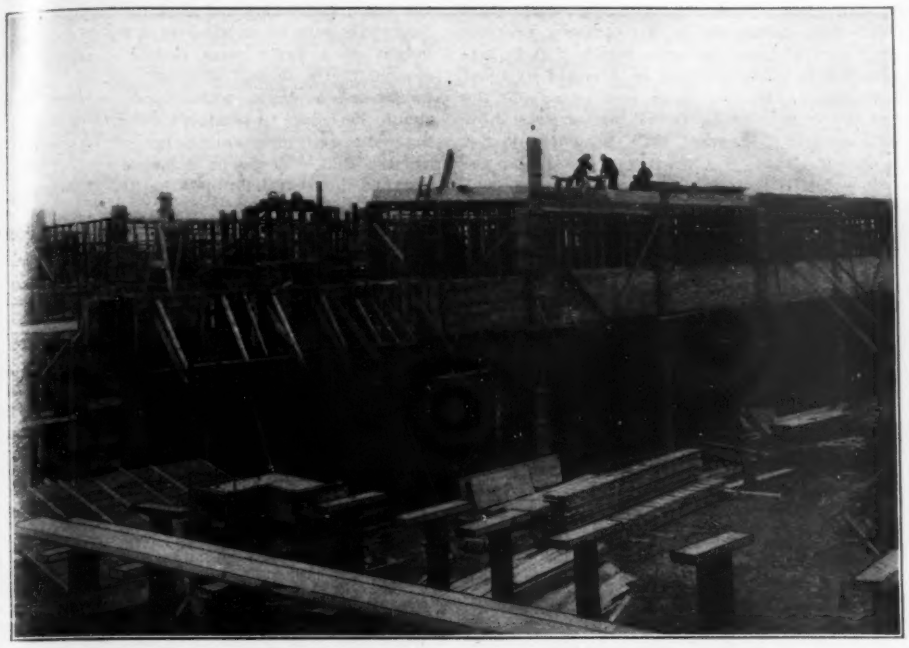


FIG. 3. VIEW OF PLANT UNDER CONSTRUCTION, SHOWING FALSEWORK AND BRACING OF FORMS.

foundations to spread your load over the area and use a reinforced superstructure in order to lighten the loads on your foundation.

AESTHETIC APPEARANCE.—The monotonous uniformity of color in concrete work can be varied by using sands or crushed stones of different color and by using different kinds of tools in dressing the work. This method of varying the color is preferable to using artificial coloring matter, which, as a rule, bleaches out and weakens the cement.

It is extremely difficult to build long reaches of plain walls quite plumb, and, therefore, even assuming that you are going to have first-class inspection on your work, it is well in the design to hide this class of defects by breaking up the plain surface by pilasters having projections from three inches to several feet. Belt courses should be used as often as consistent with appearances for a similar reason.

Don't use a very ornamental balustrade of concrete. If it is forced upon you I would suggest turning it over to one of the imitation stone companies who execute this special class of work. Remember that the balustrade or parapet receives constant close inspection by the public, who are accustomed to fine marble and granite details and are looking for it in concrete work, which is often made to simulate these materials.

Don't under any circumstances select marble details for concrete work. They are too fine. Select concrete details and you will get a better looking piece of work. If you want the best work which can be executed with concrete, trim your structure with stone block, or, if this is too expensive, with concrete blocks, cast separately, and afterwards dressed and set in place. In this way you are sure of your trimming (particularly your corners). Concrete is an excellent filler, not unlike rubble and brick, and in the best designs I think it should be used as a filler. There is no trouble getting good vertical plain faces by spading or building up the mortar face with the work, but corners and fine details give a lot of trouble.

Don't try to imitate stone work. Confess that your structure is of concrete and design accordingly. Remember that concrete is a new material with new virtues and vices. Forms are permissible with this material that were impossible for the Greeks and Romans, and the older forms may not be possible in concrete. If the engineering conditions warrant a lintel 75 ft. long, don't make it look like an arch. It is not necessary. Don't dwarf your structure with excessive paneling, which suggests parlor furniture.

Don't cut up the arch rings into voussoirs by nailing strips on the lagging to make it appear that the arch is built of ashlar unless you are going to lay up the work in alternate transverse blocks, in which case it may be desirable. Don't make concrete imitate something that it is not.

Don't put a lot of gingerbread on a simple structure just because you can get it almost as cheap. Efflorescence does not mar simple details nearly as much as it does ornate ones.

FACE WORK.—Remember in block work used for trimming mass concrete (that is, work cast on the ground and set in place) that it is not, as a rule, cheaper to use thin veneers with 6-in. and 8-in beds. Use a bed at least equal to the rise. It does not cost any more money, and when you back it up with concrete it will stand the pressure of the wet concrete, and if you have sufficient bed, the blocks will be useful in fastening the forms of the mass work. Use hollow spaces or gouge spaces in the back of trimming blocks, to bond the blocks with the mass concrete.

Remember in block work when you cast brackets, dentils, coping etc. with over-hangs that you can bed these blocks better if they are made of such length that the center of gravity is a good distance from the edge of the masonry below. This costs very little more and will enable you to bed these overhanging stones without weighting down the back and will prevent excessive strain on the facing below the bed, which, as a rule, will not stand a concentrated pressure.

Long, thin concrete blocks to be cast on the ground and set in place should be reinforced with steel so that they may be safely handled.

On large work permitting the use of air tools the concrete surfaces may be bush hammered or crandalled at an actual cost of from 1 ct. to 3 cts per sq. ft. Tooling a structure gives it a better appearance, removes form marks, lipping and efflorescence. Efflorescence may be permanently removed in this way, provided before its execution the drainage of water which has been carrying the efflorescence to the face of the wall has been cut off.

Large masses of concrete having cross sections of over say 200 sq. ft. will frequently hair crack when the concrete sets up. In using the word hair crack in this connection I mean long, thin hair lines running vertically up the face of the mass work, sometimes at intervals of 10 and 20 ft. These hair lines are apparently independent of temperature and are due to the concrete in the face of the mass work setting up before the interior. These hair lines are not seriously detrimental to the structure nor are they noticed by laymen. However, on a "show job" you may overcome this trouble by using a light reinforcing of expanded metal, wire mesh or light rods about 4 ins. from the face.

WATERPROOFING AND EXPANSION. — On large work make your stepping at the back of retaining walls in rises of about 4 ft.—smaller heights are unnecessary in large work and entail additional cost. Don't build the backs of concrete retaining walls on a batter as they are not as stable as stepped walls containing the same amount of masonry. Slope the treads of all steps at the back of retaining walls at least one inch to the foot if you want a dry showing face. This precaution is worth any amount of waterproofing. If you get pockets at the back of retaining walls which will hold water you can't expect the waterproofing man to prevent seepage.

Don't apply paper to vertical walls, as it frequently bulges, making pockets which hold water so that practically the water is forced through the wall. All that the back of a retaining wall properly built needs is a couple of coats of coal tar which must be applied when the surface of the concrete adjacent to it is dry, not superficially dry, but when the concrete is thoroughly set and the wall is dry for several inches in from the surface. Then place a light stone drain at the back of the wall as the backfilling is made. Then back up your weep holes with half a yard or more of broken stone; a handful of stone soon gets stopped up by silt.

It is a common error in subway construction to take great care in waterproofing the roof with often satisfactory results, but to take no precaution to carry this water over the expansion joint at the abutments. This results in the water running off the roof and down the face of the abutments.

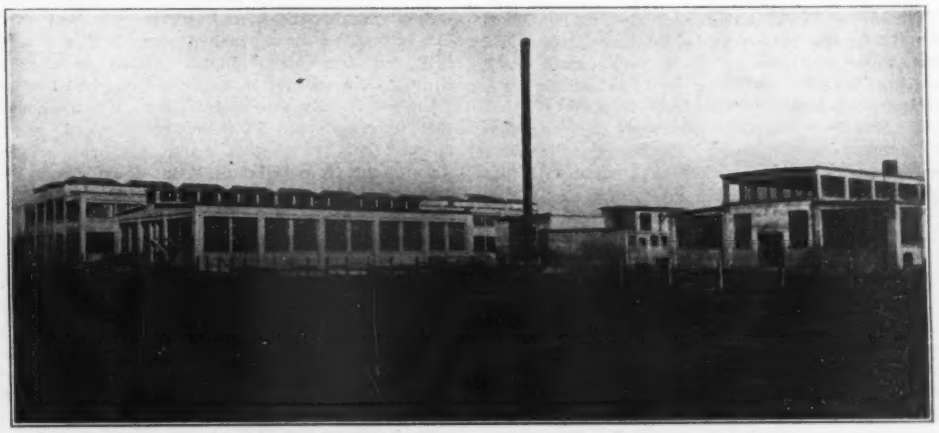


FIG. 4. VIEW OF COMPLETED PLANT.

In applying waterproofing on approximately horizontal surfaces apply the waterproofing in consecutive layers, after the method of shingling (the shingling should be done in the direction of the flow) and iron smooth upon the completion of these applications.

Provide for expansion in retaining walls by using construction joints about every 50 ft. Provide for uncertain foundations in a similar man-

ner. Provide expansion and construction joints over arches. Use expansion joints at the abutments over piers in such work and construction joints on the haunches.

If it is economical to use an arcade of spandrel arches resting on your main arches, run the axes of these spandrel arches longitudinally rather than tranversely. Of course, this cannot be done if a vista is desired through the spandrel, or, if on account of freshet or other local causes open spandrels are required. Longitudinal spandrel arches are easier to construct and simplify the expansion.

If concrete piers are subjected to the impact of heavy floes of ice they should be protected by a nosing of stone or iron.

Use fillets on all corners, excepting where the corners are built of coign blocks which have been cast separately on the ground and tooled before setting. It is practically impossible to get and maintain a fine arris by moulding concrete in place and, therefore, I suggest fillets. Concrete arrises are difficult to cast and maintain and, therefore, on dressed work I would file the edges to a ⅜-in. radius.

Gravel is practically as good as broken stone for aggregate, but concrete made of gravel cannot be tooled. Small deformations in the mold can therefore not be corrected in spaded gravel work.

When concrete is to be used as a beam or column, thin wall or arch, specify the best materials obtainable in your community. Concrete for this class of work must be carefully mixed and placed to produce a homogeneous mixture.

On work requiring various grades of concrete it is more than necessary in the specifications to vary the portions of cement, sand and stone. The quality of the materials might profitably be different and the method of mixing and placing concrete should be more careful for such work as beams than is necessary in mass work.

Many engineers seem to think that concrete is concrete and the same care should be taken in the proportions, mixing and placing in one case as in another. As a matter of fact, you can be a great deal more liberal with a contractor on heavy foundation work than in building a reinforced beam, and the contractor should be given the benefit of this fact.

In designing assume that you are going to have unskilled mechanics to do your work. It is almost impossible to get a good concrete worker unless you educate him, and this is up to the engineer, his foreman or inspector. This is not the case on other classes of construction, where the details of construction can frequently be left to experienced mechanics.

Remember in designing and also in construction work, that concrete in setting shrinks and that there will always be a very small crack existing between abutting sections of concrete work executed at different times. Concrete which sets up under a head shrinks less. Concrete rich in cement shrinks more. Concrete made with coarse sand shrinks less than that made with fine sand.

Detail your bidding sheets so that the bidders can tell exactly the amount and kind of reinforcement required. Ask for prices on additional concrete of its several classes and for additional reinforcement of its several classes. You will find as the work progresses that there will be many places where extra concrete and extra reinforcement are desirable.

Specifications.

Don't finally pass upon your specifications until your drawings have been finished and approved. Be careful to specify material which can be procured and preferably what is commonly in the market. This will save your client money and yourself considerable bother.

Don't specify methods of procedure on work in which you are not experienced. You can get experienced bidders competent to lay out their own method of procedure; and if not, a closer study of the subject than is frequently possible in the writing of specifications will enable you later to determine upon better methods than can be decided upon off-hand.

Remember that no specifications at all is better than bad ones. Just say that the work shall be first class according to the common practice in your own vicinity (or some other, if it is better), which is about all that is intended by most specifications. If you take upon yourself the authority to specify in detail just exactly how a contractor is to proceed with the work, do not then specify that the contractor shall be responsible for the work. If you want the contractor to be responsible for the work, write a general specification describing the class and character of work desired, leaving the details to the successful bidder to work out.

Don't put things in the specifications which you do not mean to enforce, as it costs your client money and frequently keeps away desirable bidders. Sometimes engineers put in club clauses for the purpose of keeping the contractors in line. This is, of course, unnecessary.

Don't copy old specifications blindly. You can seldom use a standard specification for concrete without adapting it to local conditions. Don't preserve dead letters in your specification. Here are a few clauses which I incorporated in my own specifications in 1898, but which have been omitted in my more recent ones; I think they will still be found in use by a great many engineers in their specifications, but not in the actual construction:

> Concrete shall not be passed down to its place through a chute or thrown or dumped from a height, but must be carefully lowered in a vessel and so carefully placed as to contain the constituents evenly incorporated as mixed and entirely free from foreign matter of any kind.
>
> Each batch of concrete shall be spread in place in horizontal layers not exceeding 6 ins. in thickness and shall be at once thoroughly compacted by ramming with rammers weighing about 25 lbs. each. Sufficient water must be used in making the concrete to enable the proper results to be obtained, but not enough to cause the concrete to quake under the rammer.

In regard to the second paragraph quoted, I wish to state that on a great deal of work where a reasonably rich concrete is in use it is neither impracticable in my judgment nor undesirable to bring the concrete up in 2-ft. layers if wet concrete is used. This, of course, is impossible when you get above ground, that is on finished work, as such a course would be too deep for the spaded face work. There is a tendency, I believe, in the profession to increase the layers on mass work, and I think possibly it results in getting better concrete. These large layers, of course, were impossible under the old system of using dry concrete. As to the rammer referred to I might say that most work at present is spaded, the rammers only being used occasionally when a dry batch is brought on the work, more often by accident than design.

The use of fine sand for concrete is deprecated where the concrete will be highly stressed.

Good crushed rock makes the very best sand, but in passing upon crushed stone in lieu of sand look out for rotten dust. Rotten rock going through the crusher is, as a rule, crushed to dust.

Do not specify ornate details with spaded work nor fine arrises. If these are desired, use a mortar face or, what is better, use broken stone throughout from ¾-in. or ½-in. down, depending upon the size of details desired. Tests indicate that a concrete made of the small aggregate is practically as strong as concrete of a large aggregate for the same percentage of cement.

Plastering the surfaces of concrete before the next day's work is begun is unnecessary. Concrete should be kept wet as long as practicable, provided efflorescence is not more of a factor than 8 or 10% additional strength.

Concrete can be laid in cold weather in large masses in water and below the surface of the ground. One of the best ways to protect it below ground is to permit the water to rise up over night and then pump it out the following morning. The laitance and silt which accumulate under such procedure, of course, should be carefully cleaned off.

Forms and Centers.

FORMS.—The engineer should carefully study the forming of the work to be done, prior to the award of contract, and should specify in a general way the class of work which will be required of the contractor.

A great deal of work is seriously marred by the lack of rigidity in the forms. Designers use the same size wales and studding, whether or not the work is to be carried up 2 ft. or 10 ft. The height of a day's work should be always considered in the design of form and the maximum height of a day's work used. Extreme care should be taken to reinforce corners of the framing. In designing forms for my own work I assume that concrete is a liquid of half its own weight; that is 75 lbs. per cu. ft. This rule has resulted very satisfactorily.

Forms should be designed so that they can be used in duplicate. It requires a great deal of study frequently to design the forms so that they can be so used, but it means a great deal of money in the contractor's pocket.

Bevel all small projections on forms for plastic joints, etc., so that these forms can be taken down without tearing off the edges of finished work. Bevel at least 1-16-in. to the foot. The designer of forms should always consider the practicability of the economical removal of forms without injury to the concrete.

Forms built up in section lengths should have these section lengths not longer than 6 or 8 ft. for convenience in handling and removal without injury to the complete work. For beams, camber the bottom of the forms slightly, so that any sag in the form will not give the appearance of sag to the beam.

The contractor should be required to stop up all cracks in the forms with mortar or putty, so that the mortar will not give way. Tongue-and-grooved dressed flooring or similar lagging should be used on all face work, even if this work is to be dressed afterwards, because if these forms are not practically water-tight the mortar facing will get away, necessitating unsightly patches on the completed work.

There is no practical difference in the appearance or strength of concrete, whether wood, sand, galvanized iron, cast iron or plaster paris is used in the face work forms.

ARCH CENTERS.—It is thought that better results can be obtained, and also a lower price secured, for the work, if the engineer designs the centering before bids are asked. It is certain that it gives the average contractor an opportunity to make a more intelligent bid. If the engineer is not experienced in this class of work, I would suggest that he leave the design entirely in the hands of the contractor, not attempting to cover the description of the center except in a very general way. I would suggest the following specifications for an inexperienced engineer:

> Complete drawings of the centers with a complete description of the various materials to be used shall be submitted by the contractor to the engineer.
>
> The center shall be built for the full width of the bridge, and the crowns of the centers shall be raised above the intended height of the finished arches to allow for settling when the centers are being loaded and when struck. The centers shall be provided with striking wedges or sand boxes so that the lowering of the center may be effected slowly. The lagging for the center may be in two or more thicknesses if the contractor so desires, but the top layer shall be tongued and grooved lumber and the lower layers shall be dressed to match the top surface when in place. Lagging shall have a deflection under the full load of the arch of not more than 1/16-in. The settlement of the center under its full load shall not be greater than ¾-in. for each 30 ft. in vertical height.

Under such specifications the centering should not be paid for directly, but payment for same should be included in the price of the arch concrete in place. On large work I would suggest that the contractor be required to furnish ample fire protection. On one piece of work under my supervision, requiring nearly 2,000,000 ft. of lumber, the contractor installed a 4-in. water pipe, with hose connection for each arch.

The following was used in the specifications of the Piney Branch bridge. The center, however, with the consent of the contractor, was designed by the engineer:

> 20. FORMS.—All forms for all classes of concrete shall be closely laid and strongly braced. The contractor shall, before proceeding with the work, submit drawings of the forms to the engineer for his approval. All lagging shall be tongued and grooved, and the studding for all the work shall be dressed or sawed to an even thickness. All forms except by the consent of the engineer shall be held in place by means of bolts, so made that the outer 3 ins. of the bolts can be removed after the forms are taken down, and the remaining holes shall be filled with mortar (1-3). If ⅞-in. lagging is used the studs shall not exceed 18 ins. on centers, and if 2 × 8-in. studs are used the wales shall not be less than 8 × 8 in. These wales on a basis of 2 × 8-in. studs shall not be further apart than 8 ft., nor shall the bolts

which hold them and which will have diameters of ¾ in. be further apart than 8 ft.

If lagging studs, wales or bolts are proposed by the contractor other than those described hereinbefore, they shall be such as to make a form of equal strength and stiffness to that described.

Washers shall be used under all bolt heads and nuts, and before proceeding with the concrete work forms shall be brought true to line and grade and all bolts shall be taut.

27. CENTERS FOR ARCH.—Complete drawings of the centers with a description of the various materials to be used shall be submitted by the contractor to the engineer, free of cost to the District of Columbia, and no work shall be done on the construction of the said centers until said drawings have been approved in writing by the engineer.

28. GENERAL DESCRIPTION OF CENTERS.—The centers shall be built for the full width of the bridge (25 ft. between faces of arch rings). The contractor will not be allowed to use centers having trussed spaces greater than 20 ft., but must carry posts down from the bow to suitable foundation. Bows in no case shall exceed 6 ft. 6 ins. on centers. They shall be stiffly sway-braced, both transversely and longitudinally. The foundations for the centers shall be of concrete of the same kind and according to the specifications hereinbefore specified for the permanent work. They shall be of such size as will not permit of a settlement greater than ¼-in. under the maximum loads they are designed to carry. The tendency of the centers to rise at the crown as they are loaded at the haunches must be provided for in the design, or if not the centers must be temporarily loaded at the crown and the load so regulated as to prevent distortion of the arch as the work progresses.

29. MATERIALS.—Merchantable long-leaf pine lumber (in accordance with the specifications adopted by the Southern Lumber and Timber Association, Feb. 14, 1883), shall be used throughout, excepting that sills, corbels, wedges and all other lumber subjected to side pressure shall be of white oak of the following specifications: White oak must be free from decay, splits, shakes, sawed true and out of wind, and square-edged, full-sized, free from large or loose knots or any other defects which would seriously impair its strength or durability. The wedges shall be of straight-grain oak only. All material shall be subject to the approval of the engineer. Stresses in all material for the centers will be computed on the basis of one-fifth of the breaking strain of the material used, in accordance with the tables of Messrs. Kidwell and Moore for wooden beams and columns, 1899. In the design of the center care shall be taken so that the center will be stiff. The joists, caps and bows shall not have a deflection exceeding ¼-in. under the full load of the arch, or the partial load of the arch, the concrete being figured as a liquid having a weight of 150 lbs. per cu. ft.

30. JOINTS.—No dependence will be placed in nails, except for fastening the lagging, for securing the wedges and for minor details, and then only upon the approval of the engineer. All joints shall be made with bolts and with straps or gussets of steel or iron, if in the judgment of the engineer they are necessary in the design submitted.

31. LAGGING.—The lagging may be made in two thicknesses if the contractor so desires. The top layer to be tongued and grooved lumber not less than ⅞ in. thick and the lower layer dressed to a matched top surface when in place. Lagging shall not have a deflection under the full load of the arch or under the partial load exceeding ⅛ in. The concrete being figured for partial load as a liquid having a weight of 150 lbs. per cu. ft. The lagging shall be kept wet for three weeks after the keying of the arches.

32. STRIKING CENTERS.—The crowns of the centers shall be raised above the intended height of the finished arches to allow for settling when the centers are being loaded and when struck. The centers shall be struck when directed by the engineer, which direction will not be given until the masonry above them has been completed up to the level of the bottom of the coping. Wedges shall have a batter of (one inch in ten), and the pressure per square inch on the same shall not exceed 300 lbs. per sq. in. The grain of same shall run with the batter and their contact faces shall be planed true and smooth for their entire width and length, and if so ordered by the engineer, they shall be lubricated to facilitate the striking of the centers without unnecessary jar. If the contractor wishes to use sand boxes to lower the centers, he shall submit details of the same for the approval of the engineer. The said boxes shall be waterproof and the sand used in the same shall be thoroughly washed to remove all silt and thoroughly dried before using. The centering shall not be paid for directly, but the payment of the same shall be included in the price for the arch concrete in accordance with the schedule of prices hereinafter to be determined upon.

Engineering Supervision.

On small work it is necessary frequently to get along with a single inspector, whose duty it is to see that the forms are erected on the lines given by the engineer; that these forms are stiff; that the materials and workmanship are in accordance with the specifications and approved plans, and that the reinforcement is properly placed. In addition to this, he looks after the removal of the forms, to see that the concrete work is not injured in careless removal, and that all corners are properly protected by wooden strips upon the removal of the forms. To this is added, as a rule, the clerical work of keeping track of the extra work and also the general cost of the work in its several details.

If you have to break in a green man for this work, I would suggest selecting a carpenter. It is more difficult to get a good man to look after the forming than any other part of the work, excepting that of getting a good face, and if you have not a man experienced on face work you had better camp out on the job when it comes to this part of the work. Contractors will help themselves a good deal by getting experienced foremen and mechanics for face work. Wood butchers and cheap labor will not pay a contractor who is trying to get a high grade of finished work. Contractors should bear in mind that finished concrete work requires skilled labor, just such labor as is required for first-class stone and brick work.

On any work, say, over $20,000, to be executed in a working year, I would suggest placing an additional low-grade inspector on the mixer. It occasionally occurs that the laborer pouring in the cement, through carelessness, does not put in the right amounts, and I recall two cases on my own work when the cement was entirely omitted. Of course, on work executed in daylight this omission would probably be detected, owing to the variation in its general appearance and color, but on night work it might get into the work and afterwards cause serious trouble. It is also quite common for a laborer to throw out one-third or more of hard, lumpy cement without compensating for it. This does not make so much difference in mass work, but in thin work it is, of course, vital.

It has been my practice to prohibit finished concrete work at night, although if the contractor would provide a sufficient number of arc lights there is no reason why the finished work cannot be so executed. Another reason for having an additional inspector on the mixer is that, as a rule, material is more or less superficially inspected by the engineer or inspector by going over the top of a car or barge and digging up a few pockets here and there. Both sand and gravel, however, frequently contain layers of mud near the bottom, which the additional inspector on the mixer would be able to see and condemn.

Lines and grades must be given more frequently on finished concrete work than on other classes of masonry, as it is difficult to correct small errors without unsightly results. It may be said in general also that the cost of inspection under existing conditions is higher, in order to get a first-class finished concrete job, than it would be for the same amount of brick or stone. It is thought that from 1½ to 2½% of the total cost of the work is a proper charge for inspection on first-class concrete work.

Records of the actual cost of all work should be kept where possible in order to determine upon the proper price for the extra work. The various inspectors and foremen under the direction of the assistant engineer should agree each day as to the actual cost of the extra work. Assistant engineers should go over the extra work at least twice a month with the contractor's superintendent, so that the detailed cost may be properly adjudicated while the several items are fresh in the minds of the entire force. Very complex bookkeeping details, of course, generally result in their untimely death before the completion of the work; or, what is worse, in the loss of efficiency in the engineering and inspection forces. Clerical work is a serious problem to most first-class inspectors, and therefore their reports should be simplified for them as much as possible by the use of printed forms.

Contractor's Plant and Construction Work.

Don't hurry your contractor until he has had a reasonable time to get his plant together. Good work cannot be executed with a poor plant at what are ordinarily reasonable prices. It is suggested to the contractor to bear in mind that stone crushers and concrete mixers seldom have enough power behind them to produce their rated capacity. Concrete mixers should be selected which have been in successful use. To get concrete to and from the mixer is more difficult than to mix the concrete. Mixing by hand in small quantities and at isolated points is frequently cheaper than machine. A first-class concrete plant will cost from 5 to 10% of the total cost of the work. Besides handling concrete, the plant, as a rule, has to do the following work (difficult foundation not considered): Excavate, sheet pile, mix and transport mortar, mix and transport concrete, handle lumber for falsework and forms (including demolition), handle steel, coal, broken rock and back fill. Several of these items should be carried on at one time to execute the work economically, which gives preference, as a rule, to derricks rather than cableways.

MIXER.—In selecting a mixer, give preference to a batch mixer which has been in successful operation a number of years. In this connection, however, I wish to say that the best tests I have ever had were from a continuous mixer of the asphalt type, but I think it requires more careful inspection to use this machine than it does the batch mixer. In such work as arch work, where a large monolithic day's work is necessary, be careful to select a mixer which does not easily get out of gear.

If the contractor is to use a machine which is not known to you, or if you are not satisfied with the concrete which it is turning out, I would suggest the following test. I have found it a very valuable one on my work. In one case I found that a mixer whose product did not size up well to the eye was only giving me 60% strength of what might be regarded as a first-class concrete. An experienced man would probably be able to detect the fact that the results were bad, but even experience can well be supplemented by practical test.

Take the concrete as it comes from the mixer, and from this concrete take several handfuls of mortar from different parts of the pile until you have a shovelful. Then, being careful not to mix this mortar at all, make six briquettes from it. Then take several shovelsful of concrete from different parts of the pile of concrete until you have enough for six cubes. These cubes should be at least four times as large as the largest dimension of the broken stone used in the concrete, and preferably they should be 12-in. cubes, if there is an accessible machine large enough to crush such a cube. In making up the cubes be careful not to mix the concrete. After you have made the briquettes and cubes just described, have the remaining concrete turned over by hand four times. Then repeat the sampling, making six briquettes and six cubes. Then store the two sets of briquettes and the two sets of cubes under exactly the same conditions and break them in from seven to thirty days. The latter is preferred if you can take the time. The tests of the second set of the briquettes and cubes should not show an increase in strength of 10% over the first set. However, if over 10% and less than 15%, I would suggest a second test, the results of which should be final.

Lean mixtures require more mixing than rich ones. Dry mixtures require more mixing than wet ones.

In feeding a continuous mixer by shovel, see that all of the material is fed at the loading end. It is not uncommon to see at least one of the shovel men feeding his material at the dumping end. Permit the retempering of concrete where the set is not so hard as to require a pick, provided the practice is not habitual. Do not split hairs on the mathematical proportions of the several materials which make up your concrete. This frequently causes a lot of squabbling with the contractor without any good resulting from it. Don't make the contractor pick out every piece of string, twig or leaf which you happen to see going through the mixer.

MATERIALS.

GRAVEL.—Do not accept slimy gravel (when wet), nor gravel containing many mud balls or a large percentage of gravel cemented with mud.

BROKEN STONE.—Do not accept stone with a large percentage of tailings, nor stone with more than 15% of stone dust, nor more than 1% of weathered rock, nor stone a noticeable percentage of which goes to pieces under the rammer. My objection to a large percentage of stone dust is that, as a rule, rock which, when crushed, gives a large percentage of dust generally contains considerable rotten rock, which is ground to dust in its passage through the crusher. In using run-of-crusher material, study crusher conditions so as to obtain a reasonably uniform product.

CEMENT.—The cement house should be sufficiently large to store about 20% of the annual work, or, what is practically the same thing, it

should be large enough for two months' storage. The house should be of such size that the cement can be piled and kept in separate carlots.

For mortar face work, samples should be taken from each barrel—for general work, on the basis of one sample to ten barrels; all bags sampled should be properly marked, so that they may be resampled if necessary. Cement should not be stored in a damp place. Hard lumps should be thrown out and replaced by good cement.

SAND.—Sand should not contain more than 10% of silt, except where actual tests indicate that the sand proposed is as good as the average sand generally used in the locality where the work is being executed. In this connection I have to say that I recall a case of my own work where sand containing 16% of silt gave a very much better result than a sand containing no silt and which had been originally intended for filtration purposes. On waterproofing work, as a rule, a large percentage of silt is desirable up to, say, about 15%, but facing work should not, as a rule, contain over 5%, as the greater amount of silt in the concrete the greater amount of slime there will be carried to the face work.

In placing concrete upon a sand foundation containing a sand without any silt in it, I noticed that the concrete was being robbed of its water. We were putting in soupy concrete. Fifteen minutes after it was placed it was almost dry. Besides this, I noticed that where a layer was allowed to stand a few minutes without any abutting concrete the water of the concrete had washed a part of the sand out of the concrete and also a part of the cement. There was a ring of sand about 5 ins. from the end of the layer, and the cement was extended somewhat beyond that. The sand used was a fine sand in this case. As a result of this observation, I accepted a coarse sand containing about 12% of silt, which held its water satisfactorily.

Sand Test.—On large work I have recently used the following method of testing sand, which has been quite satisfactory: Wash a considerable quantity of sand, separate the silt from it, then make up a special sample from the sand and silt that you have separated, so that this latter sample will contain the maximum silt allowed under the specifications. (If the contractor is furnishing sands from more than one locality, it will be necessary for you to make the test herein described from samples of each of the localities, as will readily be seen from the nature of the test.) Take the specially prepared sample just described and thoroughly mix the silt with the sand until the distribution is uniform. Then take a small portion of the proposed sample, about three thimblesful (on my own work I have given the inspector an ordinary test tube, with a mark on the test tube indicating the height of the final sample of sand required). Take this small sample of the prepared sand, drop it into a graduated beaker of clear water about 30 ins. high (on my own work I have used the local hydrant water, which is filtered and reasonably clear at all times of the year), shake well until the sample has been thoroughly washed. Then take a domestic pin on the end of a wire or small stick and insert it in the top of the beaker, lowering it into the beaker until the pin is no longer visible from the top, and then read the position of the pin on the graduation at the side of the beaker. Make half a dozen similar tests, using the prepared sand, and the average of these samples will be the correct gage for sand which does not contain over the stipulated amount of silt.

Of course, it is not necessary to sample every carload or barge of sand that comes in, as the bulk of it can be determined by superficial observation. If you are in doubt, however, take a number of shovelsful of sand from various parts of the car or barge, mix thoroughly and take out the necessary amount of sand for test. Drop same into the beaker, shake, lower the pin, and read the gage. If the pin is then lower than the gage, the sand has less silt than the maximum; if it is higher, it has more silt.

This is a very cumbersome thing to explain, but it is more practical than it sounds. When I first suggested it to the men engaged on the work, it was thought to be too hair-splitting to be of any practical value, but after it was actually put into use it was entirely satisfactory and enabled the men to make immediate tests of the sand instead of waiting half a day, which would be necessary under the common method; and it permitted a great many more samples to be taken. If you use it, it will take about an hour to get your first sample prepared and your gage determined, after which two or three minutes will enable you to make the test. (This system I first saw used by Mr. Allen Hazen.)

Condemn sand for a noticeable quantity of mud balls, regardless of test. In this connection an inspector should use some judgment as to the nature of the mud ball. Sometimes these mud balls are almost solid chunks of mud and at other times they contain nearly all fine quartz, with a very little mud.

An engineer should make briquettes of the different classes of sands on his work, in order that he will be certain whether or not he is warranted in accepting sand with a slight excess of silt rather than a finer or poorly graded sand which comes well within the specifications as to silt.

CONSTRUCTION WORK.

FORMS.—See that the forms are built to the lines and according to the approved plans. See that the lumber is sound and all wale joints are well spliced; that lumber, where toe-nailed, is efficiently nailed; that all forms are plumb; that all form rods have washers under their heads and nuts; that they are taut when concreting is begun, and that they remain so during the progress of the work.

Forms are designed for a certain number of vertical feet rise for a day's concrete work. Find out how many vertical feet. If for any reason the concrete is changed from a dry concrete to a wet one, consider the number of feet rise permissible under the changed conditions. In this connection I wish to say that the keeping of forms plumb is the most difficult thing which devolves upon the engineer, the contractor and their assistants. The building of plumb vertical walls can only be obtained when everybody on the work looks out for them. I have seen some very excellent concrete work done in different parts of the country where nearly all of the concrete walls were as much as 2 or 3 ins. out of plumb.

Inspectors should report to the assistant engineer any undue cutting of washers into the wood; also all form rods which have broken under the strain of the concrete. See that tongue-and-grooved dressed lumber is used where required.

Use sized studs for all finished work. See that the forms are held tightly when beginning a day's work. If they are not, the load of the fresh concrete will push out the forms, causing not only lipping, but the mortar above will flow into the crack thus formed between the lagging and the old concrete, which will make a hole in the face work. See that heavy reinforcement is placed within the forms before the form tie rods are placed, as these tie rods frequently interfere with the placing of heavy reinforcement. Forms for finished work must be held together by tie rods with coupling placed at least 3 ins. from the finished face to permit of removal of all iron within 3 ins. of the finished face. This is done in order to prevent rust stains. Forms may be held by wire on unfinished work.

Have the contractor so lay out his work that he will reduce the walking over and the working on on all setting concrete to a minimum. Allow the contractor ⅝-in. departure from established lines on finished work and 2 ins. on unfinished work. (The latter may be increased indefinitely, depending on the size and nature of the work, but as a general rule the forms should be within 2 ins.)

BLOCK WORK.—Soupy concrete—that is, concrete which contains about one more bucket of water than the concrete specified for mass work—should be used on block work. This will enable the molders to bring out the details and arrises more strongly.

Facing stone dust or grit and facing sand should all have all coarser material removed by screening; ½-in. mesh is small enough for large blocks and large details; use ⅝-in. mesh for fine work. Be careful, in passing upon the stone dust, that it does not contain a large percentage of rotten rock. All mud balls must be removed for facing work. The backs of all blocks should have recess places in the back covering practically one-fifth of the area in the back for the purpose of bonding with the mass. These recesses may be best obtained by placing wooden blocks, say, 6 × 6-in. or 8 × 8-in., in the concrete when first deposited and removing same before final set.

Cast all blocks with most important face down. All other showing faces should be cast vertical, or as near vertical as practicable. The back of the block—that is, that portion of the block which will not show in the structure—should always be molded up, because the laitance or slime always rises to the surface, giving it not only a bad color, but a weak surface, and one which is certain to hair-crack. All blocks should be molded in forms which are level—that is, which rest on a level platform—and great care should be taken by the inspector to see that the forms are stiff and do not bulge or distort under the concrete. If this is not done, the contractor will find it necessary to do a great amount of cutting, which in many cases will result in going through the mortar facing in order to get the block out of wind. All blocks should be left on their bottoms from two days to two weeks, depending on the size of the block and the nature of the cement and the condition of the weather. If not, they will be liable to break in handling.

Concrete should not be dressed (tooled) until 30 days old, under normal conditions, preferably not under 60 days. Before casting the several classes of block it should be agreed between the contractor and the inspector as to the method of handling the block, so that there will be no dog or lewis holes in the showing faces. I found on my own work that this question is overlooked frequently in the design and molding of the blocks.

Lewis holes should be cast in the blocks where practicable. Bear in mind that lewis holes must be so made as not to bring excessive pressure on the concrete, particularly near the mortar facing or near the arrises of the block. Remember that you are not handling granite. Be careful not to handle large blocks with lewises or dogs when they are green, as you will meet with disaster. The contractor must provide wood blocks and rag cushions in turning over the blocks; otherwise the arrises will be broken.

One-quarter to ⅜-in. should be allowed beyond all neat lines for dressing. All arrises should be chiseled. Better work can be gotten by using hand hammers than machine ones, and concrete details subject to close inspection by the public should be hammered by hand. All arrises excepting those of abutting joints should be rounded to approximately a ⅜-in. radius. If this is not done, the public will eventually knock off the fine arrises. Use metal templets for cutting important details.

Modify all blocks which you are unable to cast satisfactorily. Inspectors should report all blocks which in their judgment need additional reinforcement. Check all forms just before molding and keep a record of the blocks cast and see that they are being cast in the order required on the work. Paint the date of casting on each block and keep careful record of them.

Cover all blocks in warm weather with rags, bags, etc., keeping same covered and damp for ten days. Do not cast blocks in freezing weather (particularly thin ones) without taking extraordinary precautions to protect the concrete from the cold.

CONCRETE MASS WORK.—The inspector in charge of the mass work shall, before the mass concrete work is begun, receive from the form inspector an approval of the forms or shall personally examine them to see that they conform to line and grade, and that they are in accordance with the approved plan. He shall note before beginning this work that all laitance, mud, chips and dirt has been cleaned off the surface of the concrete, and that the forms (for finished

work) are also cleaned of all dirt and cement. A very unsightly face is often produced by leaving the mortar on the forms, which has resulted by the throwing of concrete into the forms in the previous day's work. He shall be governed by inspections from the assistant engineer as to the height which the contractor may be permitted to carry up a day's work.

Concrete shall be placed in 9-in. courses on finished work. With the consent of the assistant engineer, concrete may be placed in courses of 2 ft. on heavy mass unfinished work.

On finished work each day's work shall be brought accurately to horizontal and vertical surfaces. If this is not done the lipping which nearly always shows will be ragged, and therefore unsightly. The positions of bulkheads and the height to which the finished work shall be carried shall be so selected as to assure a neat bonding appearance in the finished work. The contractor should so arrange his work that the concrete may be brought up at least 2 ft. in a day's work.

Don't finish the day's work too close to an ornamental detail. You will find, if you do, that you have lipping where you can least afford it.

In waterproofing flat concrete surfaces with consecutive layers of tar or other similar material, apply the layers so that they will be shingled with the direction of the flow of water and iron well. Don't apply waterproofing material rich in water; that is, which is full of water bubbles.

On extra work the contractor is entitled to pay for moving his plant or machinery to and from another part of the work, provided the extra job is on a part of the work previously declared finished by the engineer.

Breaking into the contractor's gangs for men on odd extra jobs should not be resorted to unless absolutely necessary. However, the contractor must, as a general rule, have enough elasticity in his force and plant to handle the current extra work with the same degree of facility and economy as the contract work proper. Extra work must not be continually sacrificed to the contract work proper.

In paying for the use of machines under extra work the engineer will agree with the contractor on the price per hour complete in operation, or where extra work is continuous on the basis of the price per day. Inspectors should compare the time of men and plant on all extra work with the foremen every night and a similar comparison should be made by the superintendent and assistant engineer twice a month.

Forms on finished work should not be removed in less time than from 3 to 14 days, depending on the setting of the cement, the condition of the weather and the height of a day's work. Forms on unfinished work should not be removed in less than from 12 to 72 hours, depending on the foregoing.

On each new part of the finished work the forms should be removed as soon as practicable, so that it may be assured that the method of placing the facing is a good one; if not, there will be a chance to improve upon similar sections of work.

All layers of concrete should be horizontal, excepting near the skew backs of heavy arches, where they should be inclined as nearly to right angles to the thrust of the arch as may be consistent with a compact concrete. A dryer concrete than is generally used in mass work may properly be used here. The contractor should be required to set wooden blocks from 6 ins. × 6 ins. × 2 ft. to 8 ins. × 8 ins. × 4 ft. in the concrete, taking up approximately 10% of the area in the finish of each day's work. These dowelling blocks should be removed the following day. This is done for bonding purposes, and great care should be taken to see that this rule is carried out at all abutting sections of transverse arch blocks.

All mortar for face work should be made by hand or a regular mortar mixer.

The contractor must not continually change the facing hands who are skilled in this class of work. The uniformity of the appearance of concrete work is desirable, and is dependent largely upon this class of labor.

Transverse and longitudinal arch blocks must be cast continuously, and the contractor must not start such work unless provided with sufficient plant and material to insure the finish of such a section continuously.

The concrete should be of such consistency in general that a man in walking about in it will sink ankle deep. This may be somewhat cut down in cold weather.

Note the color of the concrete, and if it varies considerably examine for cement. Find out whether the variation is due to the color of the sand, stone or variation in the cement. Occasionally a batch may get into the work with little or no cement in it if the color is not kept in mind.

Keep your work always neat as to the grade of the concrete. If the work is not handled systematically you cannot get first-class work, nor will it be economical to the contractor.

Keep your face work always high, so that any of the concrete water which may accumulate will not go to the face work, for if it does it will weaken your face work and carry to it a lot of slime or laitance; silty sand is not good for face work.

If your concrete is too wet, don't bail out the water, as it is full of cement. (In trench work bailing may be necessary. Dry it up with a relatively dry concrete. Do not permit the hoisting engineers to continually strike the forming with the concrete bucket. Do not permit direct attachments of machinery to the forms, as it will result in vibrations which may be detrimental to your face work.

Use soupy concrete when placed in water, and in muddy water try to carry the concrete work on continuously; otherwise you will have layers of laitance and mud from ⅛-in. to 1 in. or more in thickness, which are weak and will result in the settlement of your completed structure.

In one case on my work this year the top of concrete which was used for sealing the bottom of a coffer dam, and which had been left for about ten days before the coffer dam was pumped out, was found to contain a great deal of this class of rotten material. The bottom of the coffer dam or the top of the seal was very rough, and in the valleys, which varied from 2 to 3 ft. in depth, I found as much as 8 ins. of this useless material.

Don't shovel concrete into water. Place it in as large batches as practicable and lower with bucket or pipe.

Don't dump large quantities of concrete into narrow forms. You will not be able to get sound facing work if you do.

GENERAL POINTS ON CONCRETING.

Clean all loose silt, dirt and grease from iron. Use wire brushes and putty knives.

Use soupy concrete for concrete-steel work.

Use rammers having special shapes where necessary. Bevel rammers are necessary for the backs of arches. Railroad tampers for heavy steel reinforcements. Short-handled rammers in confined places and long-handled rammers in columns. Fine stone forks are better than spades on plain face work where the concrete stones are as large as 2 ins.

It ought not to be necessary on first-class work to be continually patching up. Arrises and corners cannot be patched up except by cutting out large sections of the work. Plastering which is put on finished work will not hold unless it is put in very thin layers, and then it is doubtful. Corners can never be satisfactorily patched up by plastering. Good work sometimes may be executed on plane surfaces by first wetting the wall and then rubbing on it a coating from 1-16-in. to ⅛-in. in thickness. It takes a good deal of rubbing to get any results, and too much rubbing generally results in hair cracking as excessive cement is worked to the surface. The less cement is rubbed, the less hair cracking will result. No kind of mortar facing should be richer than 1 : 3, and when cast in place it may be as little as 1 : 4 for plane surfaces; ornamental work should not be leaner than 1 : 3. If conditions are such that plastering a veneer on finished work is necessary, I would use a mortar which was already partially set up; then add water and retemper. The reason that plastered work breaks off is that the mortar in setting up shrinks. The richer it is the more it shrinks, and the shrinkage results in leaving a hair plane between the plaster and the concrete work. The frost does the rest.

Don't leave timber work in the concrete unless it is absolutely necessary.

Note any movement or bulging of the form. Correct, if necessary, by wedging and remodel other similar forms to overcome this trouble.

Bear in mind that an excess of water weakens the concrete a little, increases efflorescence and retards the time of setting.

In work where it is necessary to throw a heavy load upon it in a short time, reasonably dry concrete should be used. Tests indicate that it is probable that wet concrete will be as strong as dry concrete in a year. However, wet concrete certainly bonds the new work better to the old work, and is particularly valuable when encasing steel, as the air is excluded and the steel becomes coated with cement. Excess of water, however, not only results in excess of efflorescence, but also in the amount of laitance or slime which appears on the surface of a day's work.

In a batch mixer (excepting the Haines gravity mixer) it does not make any practical difference as to the order in which the material is entered, excepting that the water should be last. The mixer should be kept clean, which means that it should be cleaned every night. The water should be varied with the amount of moisture in the sand and the stone, and should be greater for porous stone. Remember always that after a rain you need less water in your concrete. The amount of sand should be varied also, so as to get a uniform product with run of crusher. This is a very vital point.

The permeability of concrete may depend upon the cement, but it is certain that it is greater with a dry concrete and less with a well-graded sand and with a sand containing silt. While 10% and even 15% of silt may be desirable for concrete having a low permeability, it is probable that any amount over 10% weakens concrete, and it is certain that it increases the amount of efflorescence and slime which rises to the surface of a day's work.

Inspectors on my work use hand tallying machines to keep track of the number of batches, and at noon and quitting time they check their tally with the bags at the mixer.

On finished work which is not to be tooled the lagging should be coated with linseed oil. Glycerine leaves a fatty stain. On work which is to be tooled it is not necessary to use oil.

Concrete dumped from large buckets should be lowered as near to the concrete as practicable, particularly when deposited on concrete which is not older than 48 hours, so that the bond between adjacent layers will not be broken.

The most noticeable imperfection in concrete surfaces is the lipping between consecutive day's work. The stiffer the forms, the less the lipping. On account of this lipping I bring each day's work to a horizontal layer by using a straight edge. In mortar facing I find that if extreme care is not taken the steel plate which is ordinarily used between the concrete and the mortar facing drags, leaving an unreasonably large space between the two, and if the rammers are not particularly careful there will be no bond between the two and the mortar facing will flake off.

A great many so-called concrete workers and concrete contractors do not attempt to cast fine arrises, but assume from the start that they will fix up the work by plastering after the forms are removed. Occasionally your details will not turn out as well as they should, and under such circumstances a thin veneer of mortar is permissible, but should only be applied by an expert concrete finisher. Rubbing finished concrete with grout or painting the face with grout is deprecated. The writer once got hold of several barrels of cement rich in free lime, which he unfortunately used to paint a concrete bridge in order to give it an even finish. The results were very disastrous, and the bridge was a mass of

blotches, varying between white and a dirty pink.

Where it is necessary to cast a cornice in place, the top surface of which is comparatively flat, it is impossible to get this finish against a top form. I would leave the top form off, tamp carefully to grade, and as soon as the concrete has a fairly good set, from 3 to 12 hours, I would rub it down to an even grade with a small flat stone or a wooden float. In my judgment, it is not desirable to add any additional mortar to make this finish. However, if you have gotten a poor job on this part of the work and you are practically forced to rub it up, using additional mortar, I would roughen it slightly with a mason's axe, wet it thoroughly and rub a coat of not more than ⅛-in., using a 1 : 3 cement mortar which has been set up three or four hours.

WORK IN COLD WEATHER.—Don't use frozen materials for concrete work. By cutting off the crust of stone or sand you will get unfrozen material. All hard lumps should be thrown out. When concreting below the freezing point the stone and sand should be heated, preferably with a coil of steam pipe or with a steam jet inserted at the points where the material is being removed. In this connection, however, it is well to remember that if the material so steamed is not used at once it will give you more water and therefore more ice to contend with in your pile. With a little care you should be able to place your concrete in the work at a temperature of 60° F., regardless of the temperature of the surrounding atmosphere.

In the winter time it is well to cut down the area of your concrete work by use of bulkheads, so as to decrease the time of exposure of a single layer, which, of course, will result in running your work up to a greater height for a day's work, thereby necessitating stronger forms. There is no trouble at all in executing heavy masonry work, particularly below ground, in the coldest weather, if your materials are heated. However, in thin work (walls under 2 ft. in thickness) it is somewhat dangerous below 25° F.

Where you have a spaded or mortar finish, extreme care should be taken to protect the work, preferably by covering the outside of the studs with a layer of tar paper. This makes an ice-box sort of an arrangement, leaving an air space of the thickness of your studs between the paper and your lagging. Care should be taken to tack this paper on securely, as it is not infrequent to see paper used in this manner blown off before your concrete has had time to set. Remember that cold weather retards the time of setting of concrete. I have known a number of cases where the time of setting was two or three times as long as in hot weather. This, of course, does not apply to mass concrete.

On thin work I would suggest limiting the time of concreting to 28° on a rising thermometer and 32° on a falling thermometer. On particular work (thin work) I have found the forecast of the Weather Bureau of great assistance in determining whether or not it would be advisable to concrete. During three months of the winter when I was carrying on a very careful piece of work I found the minimum temperatures predicted by the Weather Bureau very accurate indeed.

Where I have used tar paper on the outside of trimming I have found the temperature of the air between the paper and the lagging from 8° to 10° warmer than the outside air at its minimum temperature, and it is well to bear in mind also that the side from which the wind blows is more liable to be frozen than the sides that are protected from the wind. In my own work I take special pains to protect the north and west side of the structure.

When concreting at low temperature, particularly with a mortar facing, I would suggest to the inexperienced engineer cutting out small blocks of the lagging, say, 4 × 12 ins., at different points of the most exposed sides of the work in order to note whether or not the mortar facing is being affected by frost. One morning, when the temperature at 8 a. m. was 10° above zero, with a stiff wind blowing, I found the temperature of the air between the paper and the lagging to be 20°, and upon cutting out the several blocks of lagging I found a few ice crystals on the inside of the lagging, but the mortar facing was warm and was not affected at all. The temperature of the concrete at placing was about 60°. The temperature of the air at the time of concreting was probably a little below 30° F. This same morning I took off from the top surface two layers of cement bags which had been used to protect the top surface of the concrete and found the bags frozen and ice crystals on the under side of the bags. At two or three spots where the bags had not been properly lapped the concrete was frozen to a depth of 1 in. The balance of the concrete was not affected by frost.

CONCRETE PIPE CULVERTS.*

By O. P. Chamberlain.†

In modern railway construction the use of pipes for small openings is almost universal, and in reconstruction work all wooden box culverts and many dry stone box culverts are gradually being replaced by pipe culverts. It is now regarded as the best engineering practice for waterways where areas of cross section may range from 1 to 36 sq. ft. to use pipes, either of cast iron, concrete or vitrified terra cotta, to carry small streams and surface drainage through road and railroad embankments.

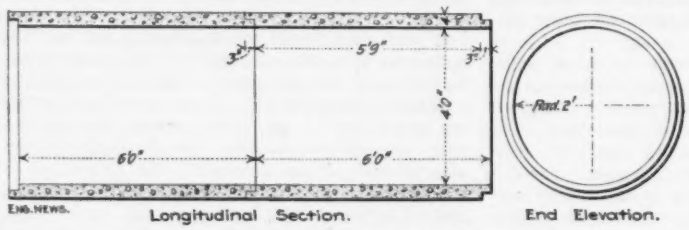


FIG. 1. SIMPLE FORM OF CONCRETE PIPE.

In the use of pipe culverts, the type that has thus far given entire satisfaction has been that constructed of ordinary cast-iron pipes with bell and taper ends laid generally in 12-ft. sections without calking at the joints. This form of culvert commends itself on account of its permanency, cheapness of maintenance and the ease with which it is installed. But while economical in the long run, it involves a heavy initial cost compared with the cost of wooden boxes and other types of small culverts. Recent experiments with concrete pipes have given rise to the hope that with them, satisfactory culverts may be constructed whose first cost will be but a fraction of the cost of iron pipe culverts and which at the same time can be as economically maintained as the latter.

A form of concrete pipe of small diameter has long been used on the continent of Europe and more recently in America for small sewers and culverts. A longitudinal section of this is shown in Fig. 1. For drain pipes of from 2 to 4 ins. inside diameter, they have stood fairly well. For larger diameters, particularly where subjected to varying vertical pressure, they have not been satisfactory. The weak joints are unable to withstand the vertical distortion consequent upon this varying pressure and fractures at and adjacent to the joints have destroyed the integrity of the sewers or culverts.

One of the principal claims of the pipe culverts for recognition, on economic grounds, is that it can be laid in the bed of the waterway on or near the natural surface of the bed of the stream without any foundation having been built for it. When laid in this manner, it is evident that, in ordinary soils, the culverts will, though laid to a uniform, straight grade line, ultimately be depressed more in the center of the embankment than at the sides and assume a grade line that is a vertical curve concave on its upper side. Any pipe laid as described above must meet this condition by having slight flexibility or play at the joints. Within the past few years, amidst the great increase in the use of concrete in engineering construction and in the diversity of its uses the attention, both of engineers and manufacturers, has again been turned to the possibility of building satisfactory concrete pipe culverts, particularly for use in railroad embankments. Two distinct forms of so called concrete pipe culverts have been produced: 1, a continuous pipe, without joints, built through the embankment, the forms being laid in place and the work of putting in the concrete being conducted on the culvert site, the character of the work being similar to the construction of an ordinary concrete arch or sewer; 2, a type of pipe which is built or molded in sections at some central manufacturing plant, whence it may be transported to the culvert site, and placed in service by simply connecting the sections in place and filling in around the pipe, in the same manner that cast-iron pipe is handled.

Fig. 2 shows drawings for some culverts of the first type as built on a western railway. In the opinion of the author it has no economic features to recommend it. The base is broadened to form a foundation and the culvert resembles a pipe only in that the cross section of the opening is approximately a circle. Its erection requires the same method of construction, involving the transportation of the raw materials to the culvert site, and the prosecution of the work by skilled mechanical labor, that is required in any arch culvert, while a semi-circular arch culvert of the same sectional area would be in every way as substantial, and the forms for its erection, as well as the culvert itself, could be built and handled more cheaply than in the type of culvert illustrated.

Assuming that it is feasible to build and install concrete pipes of the second type strong enough to resist the external pressure due to high embankments and heavy traffic, there are four essential conditions which must be successfully met, the first two involving the economical manufacture of the concrete pipes, and the third and fourth their permanency and integrity after their installation as culverts. They are as follows: 1, the concrete pipes for a considerable district should be manufactured at a central station or factory; 2, the concrete forms must be of such a character that the freshly mixed concrete can be run in from the top, each pipe being molded or built in a vertical position; 3, the pipes must be so constructed as to allow some vertical displacement so that the culvert may assume a vertically curved grade line without fracture; 4, there must be some provision for expansion lengthwise of the culvert.

Fig. 3 shows a pipe which is being manufactured and placed on the market for use in sewers and culverts.* It contains a reinforcement of four or five flat longitudinal iron or steel bars together with circular hoops which are built into the walls of the pipes. The longitudinal straps are hooked at each end. After the pipes are in place, end to end, the adjacent lengths are joined by running a joint hoop through these hooks at the ends of the bars of adjacent sections and then making up the joint to the same thickness as the rest of the

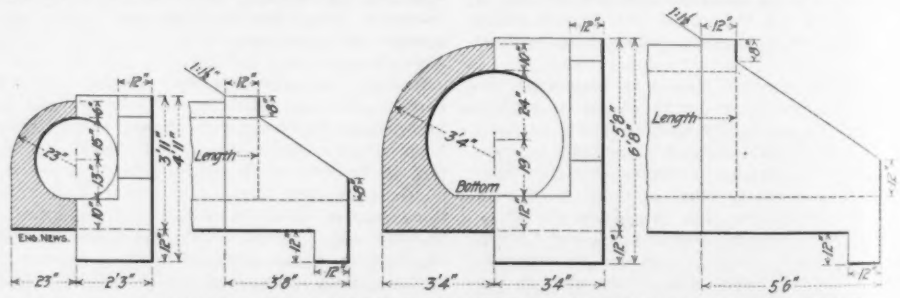


FIG. 2. DRAWINGS FOR CONCRETE CULVERT;CONTINUOUS MONOLITHIC TYPE.

culvert with cement mortar. There is no provision for either expansion or vertical displacement.

An experimental culvert tried on a railway was built substantially as shown in Fig. 4. The outside of each length of pipe was tapered at one end and the opening correspondingly spread at the other. The pipes were installed by simply inserting the taper end of one length into the flared end of the adjoining length. The results

*Abstract of a paper read at the meeting of the Western Society of Engineers, Chicago, Dec. 5.

†Chief Engineer, Chicago & Illinois Western Ry., Chicago.

*This reinforced concrete pipe of the Jackson Cement Sewer Pipe Co., Jackson, Mich., was described in our issue of March 8, 1906.

of experiments with these culverts were not satisfactory, as the pipes failed by fracture at and near the joints during settlement, there being no provision for vertical displacement without fracture.

During the past summer the author built a number of culverts, using the very simplest form of pipe, a hollow cylinder whose bases are at right angles to its axis. These pipes were built of an inside diameter of 4 ft., with walls 6 ins. thick. These pipes, which resemble in shape the hollow clay tiles used for tile drains, have been placed in low embankments where their tops are but 18 ins. below the ties. They were simply placed end to end in shallow ditches conforming with the outside surface of the pipes as nearly as it could be done by picks and shovels, and the back and top filling of the earth embankment thoroughly tamped around and above the pipes. Thus far they have given satisfactory service under heavy freight traffic. They have not, however, been in use long enough to ensure their being an unqualified success.

Fig. 5 is a drawing of the forms used in the construction of these pipes. Both forms are of wood, of ordinary wooden tank construction. The inner form has one wedge shaped loose stave which is withdrawn after the concrete has set for about 20 hours, thus collapsing the inner form and allowing it to be removed. The outer form is built in two pieces with heavy semi-circular iron hoops on the outside, the hoops having loops at the ends. When the two sides of the outer form are in position, the loops on one side come into position just above the loops on the other side, and four steel pins are inserted in the loops to hold the two sides together while the form is being filled with concrete and while the concrete is setting. After the inner form has been removed, the two pins in the same vertical line are removed and the form opened horizontally on the hinges formed by the loops and pins on the opposite side. The inner and outer forms are then ready to be set up for building another pipe.

These pipes were built under a derrick and loaded by means of the derrick upon flat cars for transportation. At the culvert site they were unloaded and put in by an ordinary section gang with no appliances other than skids to remove the pipes from the cars. As each 4 ft. section of this pipe weighs about two tons, it was not deemed expedient to build sections of a greater length than 4 ft. to be unloaded and placed by hand. On a trunk line, however, where a derrick car is available for unloading and placing the pipes, there is no reason why they should not be built in 6 ft. or 8 ft. sections.

The concrete was composed of 1 part of Portland cement and 3½ parts each of limestone screenings and crushed limestone that had passed through a ¾-in. screen after everything that would pass through a ½-in. screen had been removed. All work except the building of the forms was performed by common laborers. The cost of these pipes built under these conditions was $2.50 per lin. ft. This high price was due, in part, to the small scale on which the work was carried on, and amounts to $9.62 per cu. yd. for the cost of the concrete. It should be possible to manufacture these pipes in quantities, using enough forms to keep one or two laborers steadily at work, for $7 per cu. yd., including the cost of forms. This is equivalent to $1.83 per lin. ft. of 4-ft. concrete pipe. The cost of the lightest cast-iron pipe of the same diameter is $19.50 per lin. ft.

The following table shows the comparative weights and cost of concrete and cast-iron pipes from 1 ft. up to 4 ft. diameter; it is based on the price of $7 per cu. yd. for concrete and 3¼ cts. per lb. for cast-iron pipes. The thickness for concrete pipes of various diameters have been taken as approximately proportional to the thickness of cast-iron pipes of the same diameter, the 4-ft. pipes being used as a basis for calculation:

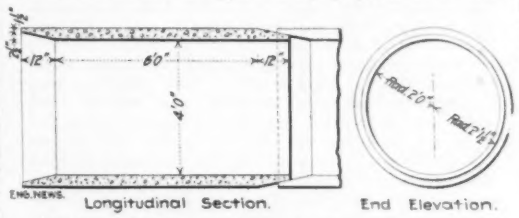


Fig. 3. Reinforced Concrete Pipe; Sectional Construction.

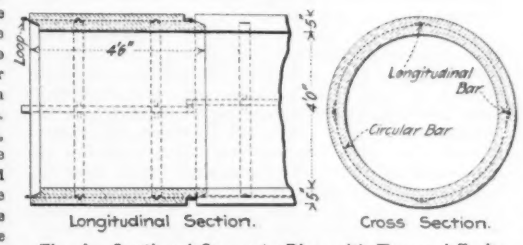


Fig. 4. Sectional Concrete Pipe with Tapered Ends.

Table Showing Relative Thickness, Weight and Cost of Cast-Iron Pipe and Concrete Pipe.

Size and kind of pipe.	Thickness, ins.	Weight per lin. ft., lbs.	Cost per lin. ft.
12-in., cast iron.....	0.38/64	75	$2.44
12-in., concrete.....	2.0	88	0.16
18-in., cast iron.....	0.47/64	167	5.43
18-in., concrete.....	3.0	220	0.36
24-in., cast iron.....	1.0	250	8.13
24-in., concrete.....	4¼	420	0.68
30-in., cast iron.....	1 1/16	334	10.86
30-in., concrete.....	4½	602	0.88
36-in., cast iron.....	1⅛	450	14.63
36-in., concrete.....	4¾	676	1.10
42-in., cast iron.....	1⅛	600	19.50
42-in., concrete.....	5¼	960	1.55
48-in., cast iron.....	1 7/16	725	23.56
48-in., concrete.....	6.0	1,131	1.83

The first cost of concrete pipes at the place of manufacture would, according to the above table, be less than 1/12th of the cost of cast-iron pipes. The cost of transportation and of installing the concrete pipes would, on account of the greater weight and greater number of pieces, probably be very nearly double the cost for cast-iron pipes. On account of the lack of reliable data regarding this cost the author is unable to give a fair comparative estimate of the cost of the two styles of culverts in place. However, since transportation and installation of iron pipes is but a small proportion of the cost of the completed culverts, it is evident that the cost of a concrete pipe culvert in place would be but a small fraction of the cost of a cast-iron pipe culvert of the same diameter, provided the pipes were hauled only moderate distances.

In Fig. 6 is shown a type of concrete pipe which has, after considerable experimenting, been designed by Mr. C. H. Cartlidge, M. Am. Soc. C. E., Bridge Engineer of the Chicago, Burlington & Quincy Ry., and adopted by him. This has been made in sizes of 2, 3 and 4 ft. inside diameter. It has, in the opinion of Mr. Cartlidge, passed the experimental stage, and it is being used extensively. This pipe is heavily reinforced by corrugated steel bars, the annular bars being so curved and placed as to be near the inside at the top and bottom of the culvert, and close to the outside on the sides of the pipe, so as to gain the greatest efficiency from the tensile strength of the reinforcing bars. The shape is very nearly that of the ordinary cast-iron pipes, the bell and taper ends being as nearly like those of the cast pressure pipes as the nature of the materials will admit. The provisions for expansion and vertical depression are ample.

When we consider the expenditures made annually for pipes to be used as culverts, the importance of securing a satisfactory cheap substitute for cast-iron pipes is of the highest importance, and while the author regards what has already been done in this line as experimental, the subject is one that cannot but be of interest to railway bridge engineers and engineers of maintenance.

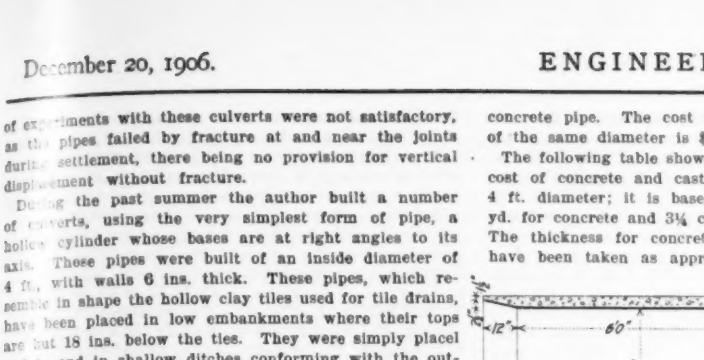

3" ¾" Pin with Loop on Top
Staves fastened to Hoops with Wood Screws 1½" long, driven from outside of Hoop.
4'0"
2'
8"
3"
Elevation of Outer Form.
Elevation of Inner Form.
Staves nailed to Templets.
5'0"
4'0"
Loose Wedge shaped Staves.
ENG. NEWS.
Two Wedge shaped Loose Staves.
2 x ⅝" W.I. Hoop
Loop for W.I. Pin forming Loose Hinge.
4'0"
Semicircular Templet of 2 Layers 1½" Boards nailed together with Clinch Nails before sawing to Shape.
Horizontal Section.

FIG. 5. FORMS FOR MOLDING SECTIONAL CONCRETE PIPE CULVERT. C. & I. W. R. R.

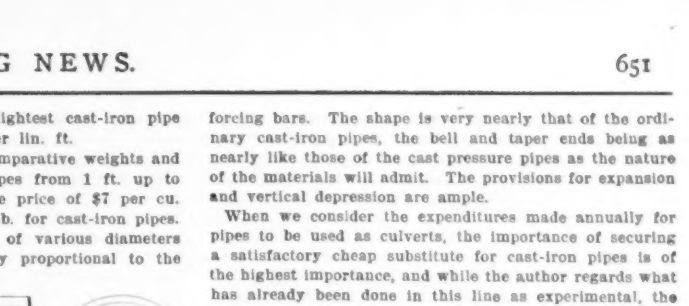


FIG. 6. SECTIONAL REINFORCED CONCRETE PIPE DESIGNED BY C. H. CARTLIDGE, C., B. & Q. RY.

THE PLANNING AND CONTROL OF TOWN-EXTENSIONS IN GERMANY.*

By T. C. Horsfall.

In the long period in which the two movements of population have been taking place in this country, the movement from the villages and small towns into large towns, and the movement from the central districts of large towns into the suburbs, similar movements have been taking place in Germany also. But though the movements have been the same in kind, there has been considerable difference in degree. The population of the large German towns has increased in higher degree than has that of our large towns, but the movement towards the suburbs has been less marked in Germany than here.

But the greatest difference that has to be noted between the two countries in connection with the movement of population, is in the nature of the new districts which have been built to receive the increase of urban population. In this country, vast areas, on what were a few years ago the fringes of our towns, have been covered with new streets, nearly all of them narrow, which lie between long rows of small houses, all very much alike. In most of these new districts very little vegetation exists; from the windows of the great majority of the houses in them no trees or flowering plants are to be seen; and, though most of our large towns have provided in the new districts a park or parks, which, as a rule, are kept in excellent and most attractive state, the immediate surroundings of the majority of the houses are so devoid of all that can create and keep alive desire to see beautiful things in the majority of the inhabitants, that the parks are not only distant in space, but are also remote from the thoughts and feelings of most of them. In our new suburban districts there is also a great lack of playgrounds for children. We all know that in the districts in question there is so little to facilitate the living of a full and healthy life that the aid of the public-house, the music hall, the betting agent, must be almost as welcome there as in the older parts of the towns. For men and women will have some change from the sensations created in them by monotonous work, and if they cannot get it, as many of them are willing to do in the occupations made possible by the existence of the beauty of nature and of interesting human productions, will seek it in the use of alcohol and other dangerous ways. Of the author's own beloved town, Mr. Justice Day has said that it is no wonder that cases of drunkenness are common there, as to get drunk is the shortest way out of Manchester.

The new districts of German towns are so constructed that a stranger often cannot tell, when he passes through one of them, whether it is inhabited chiefly by rich or by poor people. Nearly all the streets are wide, many of them are planted with trees; there are many small open spaces, made attractive with plants; public buildings are so placed as to add interest to as large a proportion of the district as possible. The tree-planted street is considered of so much importance that the Statistische Jahrbuch Deutscher Staedte which is for Germans that which the Municipal Year-Book is for us, always contains a table which tells, not only how many parks a town has, but also how many tree-

*A paper read at the Metropolitan District Meeting of the Incorporated Association of Municipal and County Engineers, held at Westminster, Nov. 16, 1906.

planted streets, and the total length of such streets. Thus we learn that Coeln, which has about 375,000 inhabitants, has 285 tree-planted streets, the length of which is 64½ miles, and that the manufacturing town of Elberfeld, which has 157,000 inhabitants, has 27 tree-planted streets, 19 miles long. In a treatise on the Housing Question, the Oberbuergermeister of Mannheim says that one of the duties of a community is to give some compensation to the working classes for the smallness of their houses by providing every part of a town with promenades, shrubberies, and playgrounds. It would be very difficult to overstate the value to the inhabitants of German towns of such places and of tree-planted streets. Large numbers of parents resort to them on summer evenings and on Sundays with their children, and while the children play in almost complete safety, the parents rest on the benches provided by the town. My attention was drawn to the high value of planted streets and open spaces many years ago, by the statement made by one of the London coroners that he held, on an average, more than fifty inquests a year on children killed while playing in their only playground —the street; and the author has therefore, ever since, tried to find out, when he has been abroad, how foreign children fare in respect of the chance of playing in safety. *The author has never found a German workman's dwelling from which a tree-planted street or garden could not be reached on foot by a short walk.* [Italics ours.—Ed.] The result of this one difference between our towns and German towns is that German town parents spend far more time happily with their children than do parents in our manufacturing towns, where, indeed, family life has almost died out.

The chief reason for the very great difference between the new districts of German towns and those of our towns is, that German municipal authorities, in common, so far as the author can learn, with those of every other civilized country except our own and perhaps the United States, have the power to control the growth of their towns by making town extension plans, the arrangements indicated on which must be complied with by all owners of the land which is within the boundaries of the town, and by all who build on it. In Prussia the power was formally given by a law, passed in July, 1875, known as the Street-Lines and Building-Lines Act, but the power had been exercised for a long time before that act was passed. Till the Napoleonic wars all the principal Continental towns were surrounded by fortifications, and most of their streets were extremely narrow. When fortifications could be got rid of by many of the towns, the desire for more air and light found expression in the creation of very wide new streets. Expression could be given to this desire more easily in Germany than would have been the case here, had our towns been suddenly relieved of encircling walls, because a large proportion of German towns were the residences of sovereigns, reigning grand-dukes, who, directly or indirectly, governed the towns. These rulers desired to have imposingly wide streets round and near their palaces, and there was a good deal of emulation among them which led each to wish that his town should be more impressive than the towns of his brother rulers. Hence, during the earlier and middle parts of the last century very wide streets and abundant planted open spaces became the rule in the new parts of German towns. With the rise of manufactures, however, towns which were not the seats of rulers began to increase in size rapidly; and, as in them the same temptations existed which have so strongly influenced the growth of our manufacturing towns, to make narrow streets and not to provide open spaces, it became necessary to give all municipal authorities statutory powers to control the width and direction of streets, and the supply of open spaces and of vegetation. The author gives here a few passages from the Prussian Street-Lines and Building-Lines Act of 1875 as an example of the laws giving similar powers, which are in force in all parts of Germany.

> The street-lines and building-lines for the making and alteration of streets and squares in towns and country places are to be fixed in accordance with public needs, by the executive part of the municipal government in conjunction with the community, or the elected members of the town council, subject to the agreement of the local police authority. The local police authority can demand the fixing of such lines, if this be needed for police reasons, of which the police authority is to judge.
>
> Lines can be fixed for single streets or parts of streets, or, to meet the foreseen needs of the near future, can be laid down, by means of building plans, for larger areas.
>
> In deciding on the lines regard must be had to the protection of traffic, safety from fire, and the public health, and care must be taken that streets and squares be not disfigured. Care must therefore be taken that adequate width be given to streets and that new building areas be well connected with those already existing.

It is those few words "Lines can be laid down for single streets or parts of streets, or to meet the foreseen needs of the near future can be laid down by means of building plans (Bebauungsplaene) for larger areas," which give German municipal authorities the power to save their people from the degradation which our suburban districts are bringing on ours. The words have received a very large interpretation. The foreseen needs of the near future are taken by the most enlightened authorities to mean the needs of the next twenty or thirty years, and hence building plans are sometimes made for very large areas. A few years ago, the municipal authority of Dusseldorf published a plan for an area of nine square miles. The words are held by most authorities to give them, not only the power to decide what streets shall be made, what shall be the width and direction of each, what squares, small planted open spaces, playgrounds, and parks shall be provided, but to give them also the power to create different "zones" or districts—districts for dwellings, districts for manufactures—each with building regulations differing from those of other districts. This power has been largely used, and with extremely good results. The words cited give power not only to reserve certain districts for dwelling, but, too, to ordain that in one dwelling-district, over which perhaps the prevalent wind passes in reaching the central districts, and in which, therefore, it is desirable that there shall be much open space and vegetation, the buildings shall not have more than two or three stories, shall all be detached or semi-detached, and shall not cover more than a small proportion of the building plots, while in other dwelling-districts four or five stories may be built, a larger proportion of each plot of land may be covered, and houses may be built in continuous rows.

The building plan is prepared by officials who have received the training of surveyors and whose experience gives them some knowledge of engineering, and of the tasks of the architect. These officials always, the author believes, work under the supervision of a committee of men cognizant of the various interests which have to be taken into account. It was recently stated by a representative of one of the large German towns, that no town of any importance fails to submit its building plan for revision to one of some six or eight well-known men who have acquired a high reputation for their skill in preparing plans which make new districts wholesome, convenient, and beautiful. A very large number of valuable books on the preparation of such plans have been published, of which "Staedt-Erweiterungen" von R. Baumeister, Berlin, Ernst and Korn, 1878, price 8s.; "Der Staedtebau nach seinen kuenstlerichen Grundsaetzen" von Camillo Sitte, Wien, Carl Graeser; and "Die Aufstellung und Durchfuehrung von amtlichen Bebauungsplaenen" von A. Abendroth, Berlin, Carl Heymann, 1905, price 3s., are perhaps the most useful for English readers. Sitte's book, which is regarded as epoch-making, gives much attention to the principles by observance of which towns are made beautiful. Abendroth's book describes the whole procedure involved in the preparation of a plan. There is an excellent monthly magazine, "Der Staedtebau," published by Ernst Wasmuth, Berlin, which is devoted to the consideration of the subject of the extension and alteration of towns.

Land is held by far more persons in Germany than in this country; the plots held by many persons are small, and many of the plots have been strips of a few furrows in width, which have been left by farmers to their children. These plots, being very long and narrow, cannot be used separately as sites for buildings, and, therefore, when a building plan is published by a municipal authority, many sales or exchanges of property are needed before building can take place. In order to quicken this difficult process, Dr. Adickes, the Oberbuergermeister of Frankfurt-a-Main., obtained the passing of a law, known as the Lex Adickes, which was at first intended for the whole of the Prussian kingdom, but was eventually restricted in its application to the town of Frankfurt. It enables the town council to expropriate all the land in a new urban district, temporarily, to deduct from the whole the land needed for streets and open spaces, and finally to redistribute the residue among the original holders in plots or shapes suitable for building purposes, each owner contributing land for public purposes in proportion to the value of his original holding.

The Prussian Lines Act of 1875, and many of the similar laws in use in the other German countries, were passed at a time when the problems created by the rapid growth of towns seemed less important than they have proved to be, and when they had not received the careful study which has since been given to them. The existing laws do not, therefore, give municipal authorities all the power which they need for the purpose of making towns as wholesome as possible. German towns suffer far more than ours do from high rents and from the inevitable result of high rents, overcrowding of dwellings. And while the evil of overcrowding in this country is felt, as a rule, only by the poorest class, in Germany a large number of persons of the middle class are compelled by the dearness of houses, to occupy inconveniently small dwellings. To enable municipal authorities to remove or mitigate these evils, the governments of Hessen and Saxony have passed Housing Laws in the last few years which have already lessened the evil of overcrowding in some parts of those two countries.* The Prussian Government published the draft of a Housing Bill two years ago which is intended to make good some of the deficiencies of the Lines Act of 1875. The author will indicate very briefly some of the changes which it is proposed to make by the Bill, but, before doing so, he must explain how it is that there is so much overcrowding in German towns. The elected part of a German town council is, in all parts of Prussia except the Province of Hanover, the districts of Sigmaringen, Stralsund, and Schleswig, and city of Frankfurt-on-the-Main, elected by a most undemocratic method known as "the three classes system." By this method the ratepayers who pay one-third of the rates and taxes in the largest amounts, have the right to elect one-third of the whole number of elected members of the town council, those ratepayers who pay the second third in the next largest amounts, elect another third of the elected members, and all the other ratepayers whose contributions make up the remaining third of the rates and taxes, elect the other third of the members of the town council. The system gives nearly all voting power to the largest ratepayers, and reduces each of the voters of the third class to a close approximation to insignificance. The Berlin figures will prove this. There less than 0.33% of the total number of municipal voters have the right to elect one-third of the members of the town council, and 3% of the total number of voters control the election of two-thirds of the members of the council. But this is not all. Half the members of each town council must be house owners. Hence the interests and supposed interests of rich people in German towns are very safe from attack. And, unfortunately for the working classes in those towns, it is to the pecuniary interest of many persons that the price of land shall be high, and that rents shall also be high. For, as the author has already mentioned, when the towns were freed from their encircling walls and forts the new streets in many towns were made very wide, and as if small houses were built on each side of a very wide paved street the rents would have to be extremely high to cover interest on both the cost of the building, its site, and the land to the middle of the street, houses of five and six stories were built. Another mistake also was made, too great distances were left between the streets, and consequently each building-site was very large, and the tall house standing by the street did not cover enough of it to enable moderate rents to pay interest. So blocks of tall buildings were added behind those standing by the streets. As these buildings were so tall they had to be solidly built, and the cost of the expensive structure and of the land in the street and site, even when distributed over many dwellings, made it necessary to charge high rents. Moreover, the great size of the houses, indicated by the fact that in Berlin the average number of inhabitants is 52.6 per house, and in Breslau 35.4, makes it impossible for any one who cannot command a good deal of capital or credit to build, and makes the supply of new houses much less abundant than it is in this country, where a house can be built for less than £200 ($1,000). High rents for dwellings and high prices for land having been thus created, it is to the interest of every house-owner and every owner of land that no change shall be made in the arrangement of new streets and in building regulations which will lower rents and prices of land, and at least some members of the elected part of a German town council are obviously fit instruments for the defence of the interest of the owners of both kinds of property. Happily, a considerable number of men of high character and great intelligence are elected, and these and many of the members of the executive portion of the municipal authority strive hard to protect the interests of the whole community, and especially those of the poorest classes.

The Oberbuergermeister and Buergermeister of a German town, and a number of men called Beigeordneten, who do the kind of work which in this country is done by the chairmen of committees of a town council, are all paid salaries, and are elected by the members of the town councils, in Prussia for periods of twelve years, and in other German countries for nine and six years. At the end of the first or any later period of office, the Buergermeister and the Beigeordneten can be re-elected or not, as the town council decides; but if it fails to re-elect one of them, it has to pay him a pension, the amount of which varies according to the length of time for which he has served. These men, knowing that if they are efficient, courteous to their colleagues, and of good behavior, they will probably remain in office as long as they wish to do so, have time and every motive to seek to advance the interests of the town in all possible ways. It is under their superintendence that the admirable building plans, of which the author has spoken, are prepared and all the other work of the authority carried on, and from them come many of the most valuable suggestions for reform.

To return now from this digression to the proposals of the new Prussian Housing Bill, which embodies many of the suggestions made by members of the executive portion of the municipal authorities.

The bill states that consideration for the need for

*Some of the provisions of the Hessian and Saxon acts are given in "The Example of Germany," by T. C. Horsfall, Sherratt and Hughes; price 1s.

dwellings must be added to the considerations to which regard must be had in fixing street and building lines; that care must be taken that there be provided open spaces abundant in number and in size (also town-gardens, playgrounds, and recreation grounds), building sites of suitable depth for dwelling purposes corresponding to the varied need for dwellings, also that streets of wide width shall be made, and that building land corresponding to the need for dwellings shall be opened out by the fixing of lines.

Some town councils have felt doubt as to whether the Lines Act of 1875 gives them power to create separate building districts or zones, each with its own building regulations, and as the Prussian Government is convinced that this should be done, the bill states:

"By Building By-Laws can be regulated:

"(1) The graduating by districts, streets, and squares of the extent to which sites shall be covered with buildings;

"(2) The separation of particular districts, streets, and squares in which the erection will not be allowed of buildings which are likely, in working, to cause the neighboring inhabitants or the public, danger, injury, or annoyance, by diffusing bad smells, thick smoke, or unusual noise;

"(3) The plastering, painting, or pointing of buildings mainly serving as dwellings, and of all buildings situated on streets and squares;

"(4) Proceedings against buildings which disfigure the streets or public places in towns or in country places."

The German Governments, and, the author thinks, all German students of the housing problem, know that towns cannot be brought into and kept in a condition which shall make it possible for human beings to have good health, physical, mental, and moral, in them solely by means of town building plans, and of the building regulations which form part of such plans. They believe that town councils must own much land, and for this purpose must have the right to buy it whenever they can get it as private persons may; they are convinced that every house containing small dwellings, and the servants' and apprentices' rooms in large houses, must be carefully inspected at not very long intervals of time; that cooperative and other societies must be encouraged to build wholesome small dwellings by being provided, by direct or indirect aid from Government, with loans of money at low rates of interest, and that town councils must be enabled to obtain a considerable proportion of the money needed to defray the cost of making towns habitable from the persons who now gain most by the growth of towns, by being empowered to rate land on its selling value, and levy rates on unearned increment. Legislation for the attainment of all these objects has been already passed by several governments, and is promised in the near future by the others. But while the importance of all these other things is admitted by all German social reformers, they all know that the supremely important thing is the building plan. In all lists of the measures needed to ensure that towns shall be made less dangerous to health and strength than they now are, the improvement of the building plan and its necessary concomitant, building regulations, has the first place. No one connected with a German town, rich land owner, or poor landless tenant, doubts that it is necessary for his welfare that such plans shall exist. In Professor Baumeister's book on the enlargement of towns, the English towns are mentioned as the only modern examples known to him of the monstrosity, towns built without any plan at all. The author trusts that our towns will soon cease to have this evil distinction.

A CONFERENCE of representatives of manufacturers and users of forest products was held at Washington, D. C., Nov. 16, to urge the establishment of a National Wood-Testing Laboratory. The delegates advocated the presentation of a bill in Congress, during the present session, to appropriate the necessary sum of money to establish and equip such a laboratory and voiced their sentiments in the following resolution:

Resolved: That it is the unanimous sense of this conference that a laboratory for testing the strength and other characteristics of wood, and for solving problems connected with its economic use, is absolutely essential to the manufacturers and users of forest products of this country; that we ask these interests to petition Congress for an appropriation of $200,000 to establish such a laboratory, and that it be under the control of the Forest Service of the Department of Agriculture.

The Government now has wood-testing laboratories at Yale University, New Haven, Conn., at Purdue University, Lafayette, Ind., at the University of Washington, Seattle, Wash., and at the University of California, Berkeley, Cal. These laboratories have made a number of important tests, but as yet very little is known of the properties of many American woods. For this reason a National laboratory to be operated by the Forest Service in co-operation with lumber manufacturers and users is advocated. The conference perfected its organization by electing Mr. R. K. Goodenow, of the Canton Box Co., Baltimore, Md., Chairman, and Mr. Thomas E. Will, 1311 G St., N. W., Washington, D. C., Secretary.

A HIGH-SPEED SPROCKET CHAIN.

A link chain belt for high speeds is shown in Fig. 1. It is claimed that it is practically noiseless at speeds of 850 r. p. m., that it does not become clogged from grease or dirt, that it wobbles less and requires less space than the ordinary style of sprocket chain, and that it is the only cross-belt chain that will work within 4-ft. centers in the smaller sizes and from 8 to 12-ft. centers in the larger sizes.

The chain is made by the Link Chain Belt Co., 52 Dey St., New York, in six widths, ¼-in. to 2

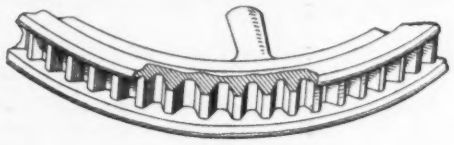


Fig. 1.

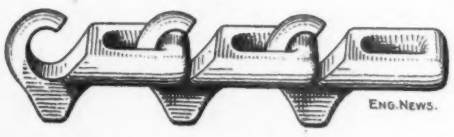


Fig. 2.

Figs. 1 and 2. Link Chain and Sprocket Wheel for High-Speed Transmission.

ins., with breaking strains ranging from 700 to 15,000 lbs. In all cases the chain should be run with the hook toward the front. By merely turning over the alternate links, a detachable link driving chain is formed which can be used as a cross-chain on the same sprocket.

The sprocket wheel used in connection with this chain belt is, as shown in Fig. 2, simply a spur-gear wheel with projecting flanges on either side of the rim.

A REMARKABLE COMBINATION OF STATE AND CORPORATE ACTION IN A WYOMING IRRIGATION SYSTEM.

A novel plan for ensuring the development of an irrigation enterprise in responsible hands and in a systematic manner, for a portion of the Shoshone Indian Reservation in Wyoming, opened for settlement on June 15, 1906, has been devised and carried out by Mr. Clarence T. Johnston, M. Am. Soc. C. E., State Engineer of Wyoming. A pamphlet describing this enterprise has been issued by Mr. Johnston, whose address is Cheyenne, Wyo. The necessity for action on the part of the State was made evident to Mr. Johnston by the receipt of letters from people "anxious to see early development take place through *bona fide* investors," and to protect the settlers from speculators. It was also considered highly desirable to hasten as much as possible the provision of water for the settlers, so that they might be provided with that necessity as soon as possible after entering upon the land. Another object sought was to substitute in place of a large number of filings for small irrigation schemes, a single comprehensive scheme that could be carried out by a responsible company and would provide ample water and guaranteed water rights for all the settlers. After correspondence with the Interior Department, and through it with the Indian Commissioner, the Secretary of the Interior finally gave formal permission to the State Engineer of Wyoming to enter upon the reservation before it was thrown open to settlement and make surveys for irrigation works. The necessary permit was received by telegraph on Feb. 20, 1906. On March 5 three surveying parties left Cheyenne and immediately proceeded with the necessary surveys. The parties were provided with explicit instructions from Mr. Johnston as to methods of procedure and general plan of the proposed works. By July 1 the surveys and estimates for the irrigation works had been completed, but some surveys for perfecting rights of way and for classifying land under the canals were made after that date. The total expenditures for surveys up to August 1 were about $6,500. The sum of $10,000 was subsequently paid to the State for these surveys and for certain associated supplies needed by the company that contracted to build the irrigation works.

In March, 1906, wide publicity was given to the fact that the surveys described were about to be made and that bids were desired from companies prepared to construct irrigation works in accordance with plans to be based on the surveys. Bids were opened on Aug. 1, 1906, and on the following day it was decided to award the contract to the Wyoming Central Irrigation Co. (Joy Morton, President; Edward H. Stearns, Secretary). Under the terms of this contract the company agreed to build the proposed works and to sell water rights to settlers, and eventually to transfer the works to purchasers of water rights. It was agreed that construction should be started within three months and should be continued to completion, which latter was to be within five years from the date of the contract. The company agreed to sell settlers perpetual rights to water, "not to exceed ½-cu. ft. of water per sec. for each 40 acres of land," the water to be delivered through lateral ditches provided with the necessary gates. The company reserved to itself the right to utilize water from the irrigation system for power purposes wherever this could be done without prejudice to the settlers. The prices for perpetual water rights agreed upon were as follows: (1) Full payment in advance, $20 per acre; (2) Part cash down and balance in five annual payments, $25 per acre; (3) Part down, balance in ten annual payments, $30 per acre. Deferred payments under (2) and (3) bear 6% interest, but purchaser to have privilege to make complete payment at any time. Still another plan of purchase provided for five equal annual payments at a total of $30 per acre without interest, or ten annual payments at $38 per acre without interest, with the privilege in either case of completing the deferred payments at any time and receiving thereon a discount of 5% per annum on the unexpired period. In addition to the payment for perpetual water rights, the settlers under the contract are liable to assessment from the date of delivery of water, on a *pro rata* basis, of a sum sufficient to meet the maintenance cost of the irrigation system, but this sum not to exceed 40 cts. per acre per annum. Finally, the contract provides for turning the irrigation system over to the settlers when the company shall have received payment for all or for 90% of the total water rights involved. General specifications describing the extent and character of the irrigation works were prepared by the state engineer and agreed to by the contractor; they are included in the pamphlet mentioned at the beginning of this article. They provide for two canals: one 35 miles long, 35 ft. wide on the bottom, and of sufficient depth to carry 8 ft. of water; and another 40 miles long, 80 ft. wide on the bottom, and of sufficient depth to carry 10 ft. of water—the side slopes in either case to vary with the character of the soil. Provision was also made for laterals to bring the water within three miles of each tract of land to be irrigated, and further provision was made for head-gates, diversion dams, and other accessories. The agreement called for an ultimate minimum reservoir capacity of 300,000 acre-ft., formed by dams of earth or masonry, or, where good construction could be guaranteed, loose rock.

Mr. Johnston informs us that there is something like 300,000 acres that can be irrigated. The lands are of fine quality and lie at an altitude of somewhat less than 5,000 ft. above sea level or approximately the same as the Poudre Valley in Colorado between Greeley and Fort Collins.

REGULAR ELECTRIC TRAIN SERVICE was inaugurated on the New York Central's suburban lines Dec. 11, by running four electric trains from the Grand Central Station to Highbridge, over the Harlem Division of the road. These trains, known as Yonkers locals, were drawn from Highbridge to Yonkers by a locomotive, as the electrification of the line between these two stations is not yet completed. It will be some time before electric trains will be run during the rush hours, and for the present only eight of these trains a day will be run over the line. The new temporary station at 43d St. and Lexington Ave., was opened Dec. 13, and hereafter all local steam trains of the Harlem Division, both New York Central and New Haven roads, will arrive and depart from this station.

STEAMSHIP TERMINAL WITH CONCRETE PILE PIERS AT BRUNSWICK, GA.; ATLANTIC & BIRMINGHAM RY.

The plans for the new water and rail terminals of the Atlantic & Birmingham Ry. at Brunswick, Ga., provide for five freight or steamship piers of varying length, a coal pier, a lumber yard with wharf or platform for loading lumber onto vessels, a power house, and a number of freight sheds and minor structures. The first portion of these terminal works is now under contract and includes the following: (1) About 200,000 to 300,000 cu. yds. of dredging and filling; (2) two piers 140 ft. wide, 350 and 750 ft. long, with a slip 180 ft. wide between them; (3) a sheet-pile bulkhead about 1,000 ft. long, on the shore line; (4) a lumber shipping platform 60 × 180 ft., at the shore end of the slip; (5) four sheds on the piers and four storehouses 58 × 400 ft. on shore. A specially interesting feature is that concrete piles are being used. Alternative plans were made. One of these called for the use of creosoted yellow pine piles for the piers and buildings, and sheet piling of the same material for the bulkhead; the other called for concrete piles throughout, except that the outside rows on the piers were to be of creosoted timber. This latter system of construction was adopted. The terminal works were designed by the engineers of the Fore River Shipbuilding Co., of Quincy, Mass., which has the general contract, and to that company we are indebted for copies of the plans and specifications. The contract for the piers has been awarded to A. F. Chapman & Co., of Buffalo, N. Y., and work is now in progress.

PIERS.

The general arrangement is shown in Fig. 1. The piers will be 140 ft. wide, with the floor 7 ft. above high water or 14 ft. 4 ins. above the level of mean low water. At the middle of each pier, however, is a depressed portion 4 ft. 4 ins. below the main floor for a width of 24 ft. In this depressed portion are laid two railway tracks, so that the floors of the cars are approximately level with the floor of the pier and sheds. There are 16 piles in each bent, and the bents are spaced 11 ft. 6 ins. apart longitudinally. The spacing of the piers in the bents is shown in the cross section, Fig. 2. The two outside piles of each bent are of timber, protected by fender piles and braced by spurshores or brace piles, also of timber. Horizontal bracing timbers are bolted against the piles, and the timber caps are pairs of timbers resting on shoulders on the piles and bolted together. Floor joists support a 3-in. plank floor.

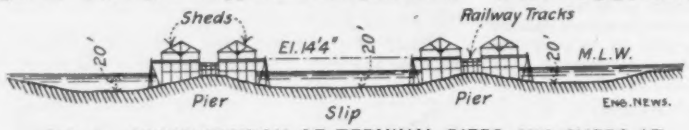


FIG. 1. CROSS-SECTION OF TERMINAL PIERS AND SHEDS AT BRUNSWICK, GA.; ATLANTIC & BIRMINGHAM RY.

There will be about 1,450 concrete piles, from 32 to 50 ft. long; the different forms are shown in Fig. 3. We give below an abstract of the specifications for their construction:

SPECIFICATIONS FOR CONCRETE PILES.—The piles for the piers shall be rectangular 10 × 16 ins. for 22 ins. down from the head. From this point to 10 ft. from the end they shall be 16 ins. square, and the lower 10 ft. shall taper from 16 ins. to 8 ins. square at the ends. The concrete shall consist of the following proportions: One part Portland cement, 2 parts clean, sharp sand, 3 parts of gravel or broken stone. It is essential that the quality of concrete shall be such as to be impervious to salt water, and, therefore, the company's engineer shall have the right to increase the amount of cement as may be necessary in his discretion to fill the voids in sand and gravel used on the work; the above amount specified being considered sufficient with the best of sand and gravel or broken stone. It is preferable that the concrete for these piles be mixed by a concrete mixing machine, and it must be mixed to the thorough satisfaction of the engineer in charge. The sand shall be clean, coarse and sharp, and free from loam or dirt of any description. Broken stone, if used, shall be of such a size that no dimensions of the same shall be greater than 1 in., and shall not include screenings. If gravel is used in place of broken stone, it shall be clean screened gravel of such size that no dimensions shall be greater than 1½ ins.

Reinforcement for these piles shall consist of four ⅜-in. round steel rods, each rod in one length without welds, situated in the four corners of the pile, and extending from a point 22 ins. down from the head to the bottom of the pile, where they are to be firmly fastened to the pipe used for water jet by wrapping with ⅛-in. iron wire. At points 12 ins. apart, between the top and bottom of the pile, ¼-in. round steel clips shall be placed as shown in the drawing. There shall also be placed within the pile and for a distance of 3 ft. down from the top of same, a reinforcement of Clinton electric welded fabric with 3-in. square mesh, longitudinal wires to be No. 3 gage, transverse wires No. 10 gage. This reinforcement to be bent into a round form and located inside the other reinforcement. This fabric may be obtained from the Clinton Woven Wire Co., Clinton, Mass. In the center of the pile, and extending for a distance of 20 ft. up from the bottom, there shall be a 1½-in. pipe to be used in water jetting the pile into the ground. This water jet shall be reduced to a 1-in. opening at the bottom and shall leave the pile at a distance of 20 ft. from the end, as shown.

All steel which enters into the construction of the concrete piles shall be of the grade known as rivet steel and shall be equal to the following requirements: Ultimate strength, 48,000 to 58,000 lbs. per sq. in.; elastic limit, not less than half of the ultimate strength; percentage of elongation, 1,400,000 divided by the ultimate strength; bending test, 180° to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

These piles shall be cast in a square form with edges bevelled 1½ ins., and the form may be allowed to lie on the ground during the process of making. When any one pile is started it shall be carried through to completion without interruption so as to avoid all lines of cleavage that might result in a weak spot in the pile. After it has been allowed to set a sufficient length of time to retain its shape, the form shall be removed and the pile sprinkled and kept in a damp condition for at least seven days, after which it shall be allowed to set for at least three weeks more before driving. The concrete pile shall

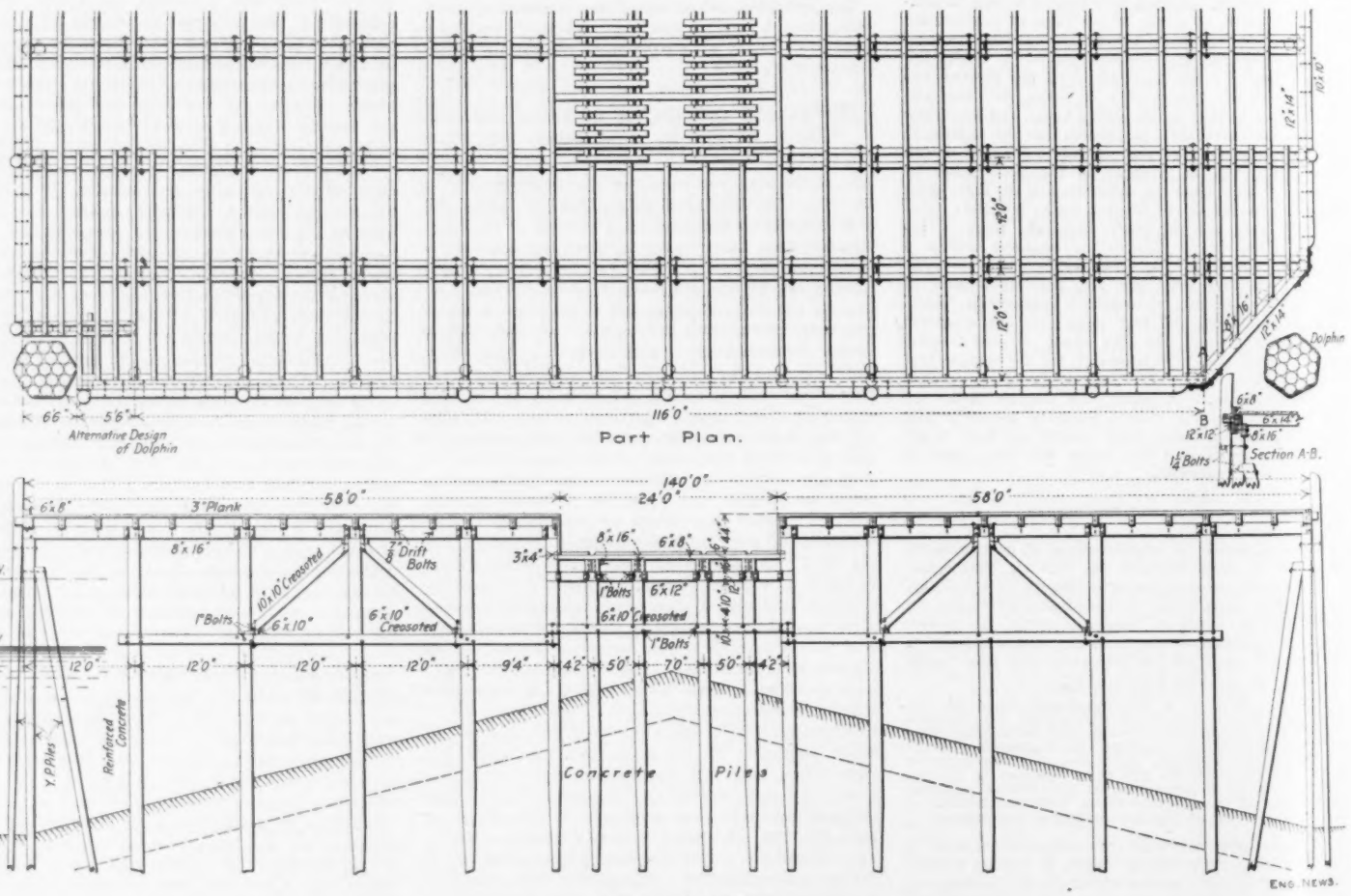


FIG. 2. CROSS-SECTION OF PIER WITH CONCRETE PILES.

be driven by water jet to within 12 ins. of the required grade, and the rest of the distance to as near the exact grade as possible by means of a hammer.

There shall be a 3-in. shoulder cast on two sides of each pile, 22 ins. down from the head and 6 ins. below the grade of the bottom of the cap. This is done so that in case the pile is driven below the required grade the girder cap may be placed at the proper grade and the space between the top of the shoulder and bottom of

the girder cap filled with concrete, as shown. If it is found possible to drive these piles to the required grade it may be of advantage to place pieces of pipe in the head at points indicated by the engineer, to allow of passing 1 in. bolts through the same for fastening the girder caps to the pile, and this method will be allowed if the contractor so prefers.

The main piles of the piers shall be spaced 12 ft. apart, both in the transverse and the longitudinal directions of the piers. The concrete piles shall be tied together by two braces of 6 × 10 in. creosoted yellow pine timber 48 ft. long, which shall be bolted to the piles. There shall also be diagonal bracing consisting of 10 × 10-in. creosoted yellow pine. The outside piles of both piers shall consist of one main pile, one spurshore and one fender pile, all to be of yellow pine and creosoted. These piles should be at least 15 ins. diameter at the head, 7 ins. at the top and 50 ft. long. They shall have not more than 6 ins. spring from a straight line drawn from the center of the head to the center of the top of the pile, and shall be driven to sustain a safe load of 25 tons figured by the following rule:

$$L = \frac{2WH}{S+1}$$

in which L = safe load in pounds to be carried, W = weight of hammer in pounds, H = drop of the hammer in feet, and S = penetration of the pile in inches.

The yellow pine spurshore and fender pile shall be driven on a batter, and fastened to the main pile by 1¼-in. bolts. The spurshore shall be notched into the main pile at distance of 1½ ins. The 1¼-in. bolt used in fastening the fender pile to the main pile shall be countersunk into the fender pile a distance of 2 ins. Between each two fender piles and fastened to the 12 × 14-in. stringer shall be placed a 10 × 10-in. yellow pine filling piece with ⅞-in. drift bolts 20 ins. long. All bolts shall be 1-in. machine bolts with square heads, unless otherwise indicated.

The superstructure or floor framing is all of yellow pine; each cap is composed of two 8 × 16-in. timbers, placed on opposite sides of the pile and bolted together with four 1-in. bolts. On these are stringers 6 × 14 ins., boxed out 1 in. over the caps and drift-bolted. The outside stringers are 6 × 14 ins. Upon the stringers is spiked the 3-in. plank floor. The piles under the railway tracks will have diagonal bracing, and will carry caps and stringers, the latter supporting ties 6 × 8 ins., 8 ft. long, except that every third tie extends under both tracks. All creosoted piles and timbers are required to have absorbed 20 lbs. of oil per cu. ft., with a penetration of at least 2½ ins. Where timbers are cut for framing, the exposed surface must be given four coats of hot creosote oil before the other timber is laid upon it; where the end is exposed after cutting, it must be given a coating of a hot mixture of 1 part coal tar to 1 part air-slacked lime.

At each outside corner of each pier will be a dolphin or fender composed of a cluster of 19 creosoted piles 60 ft. long, bound together with ¾-in. steel-wire rope. Cast-iron mooring bitts will be bolted along the sides of the piers at intervals.

Both piers will be 140 ft. wide, and on each side of the depressed portion of the floor will be a one-story freight shed 45 ft. wide (or 51 ft. over the roof), the four sheds being from 300 to 800 ft. long. The freight sheds are to be of timber construction, with three rows of posts, the posts and trusses being spaced 20 ft. c. to c. Their construction is shown in Fig. 4. The storehouse is 400 ft. long and 57 ft. wide (or 70 ft. over the roof); it has four lines of posts spaced 19 ft. c. to c.; the posts and roof trusses form bents 20 ft. apart. The structural design is shown in Fig. 5. This building will be on filled ground, and will be supported by eight lines of concrete piles, spaced 10 ft. c. to c. in both directions. These piles, which are shown in Fig. 3, are 18 ft. long, reinforced by a 1-in. pipe and four ¾-in. rods, which are connected at intervals of about 12 ins. by rectangular hoops of ⅜-in. steel wire. The caps are secured to each pile by a machine bolt ¾ × 24 ins., passing through the timber and grouted into the 1-in. pipe of the pile. The concrete sheet piles for the bulkhead, Fig. 3, will be 6 × 14 ins., 20 ft. long. The lumber loading platform is of very similar construction to that of the piers.

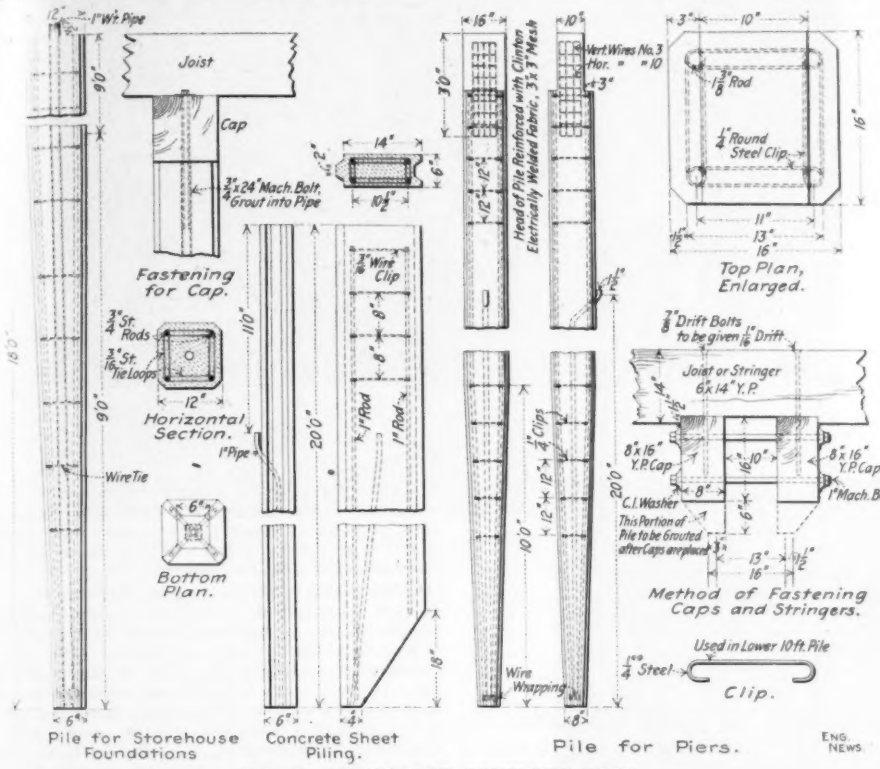


FIG. 3. DETAILS OF CONCRETE PILES.

THE ELECTRIFICATION OF THE ERIE RAILROAD on that portion of the Rochester Division lying between Rochester and Avon, and on the branch between Avon and Mt. Morris, is nearing completion. This equipment is interesting on account of being the first application of the single-phase system to a steam railway, using motor cars of the interurban type. It differs from the single-phase system being installed on the New York, New Haven & Hartford Railroad in that motor cars will be used instead of electric locomotives hauling standard passenger coaches. About 34 miles of single track, besides siding, will be equipped for electric traction, and it is thought the system will be in operation next month. The power will be supplied by the lines of the Niagara, Lockport & Ontario Power Co., which receives three-phase current generated at the new station of the Ontario Power Co. at Niagara Falls. The three-phase current will be received at 60,000 volts by a sub-station located at Avon, N. Y., which is about 19 miles from Rochester and 15 miles from Mt. Morris. Three 750-KW. transformers will here convert the 60,000-volt three-phase current into 11,000-volt single-phase current, which will be fed directly to the trolley wires. The catenary type of overhead trolley construction is used. Triple petticoat porcelain insulators support the messenger wire. The trolleys are of the "pantagraph" type, and make sliding instead of rolling contact with the trolley wire. They are raised or lowered by a light-jointed framework and are controlled by air pressure. Rails of 80-lb. weight are used, and the bonding of them is now nearly completed. The six new motor cars being provided for operation on this line are each equipped with four 100-HP. motors, one on each axle; there is also a transformer on each motor car for lowering the 11,000 volts to the relatively low pressure at which the motors are designed to operate. The Westinghouse electro-pneumatic system of multiple-unit train control will be used, enabling the cars to run at a maximum speed of 50 miles per hour. Westinghouse, Church, Kerr & Co., New York, N. Y., engineered the entire work, and have now been authorized by the Erie Railroad Co. to furnish estimates for the complete electrification of the entire Rochester Division between Rochester and Corning, New York.

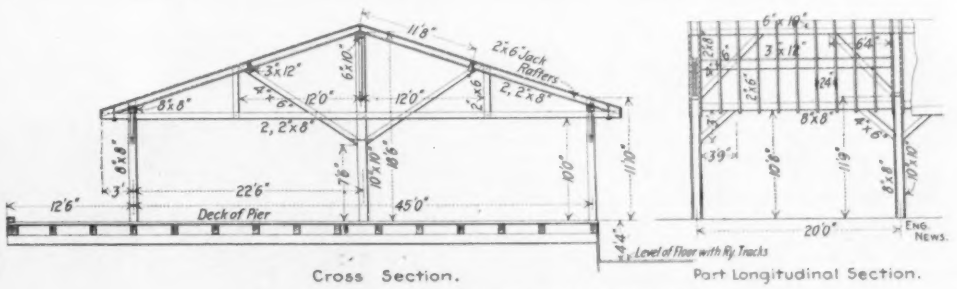


FIG. 4. CROSS-SECTION OF SHED FOR PIER.

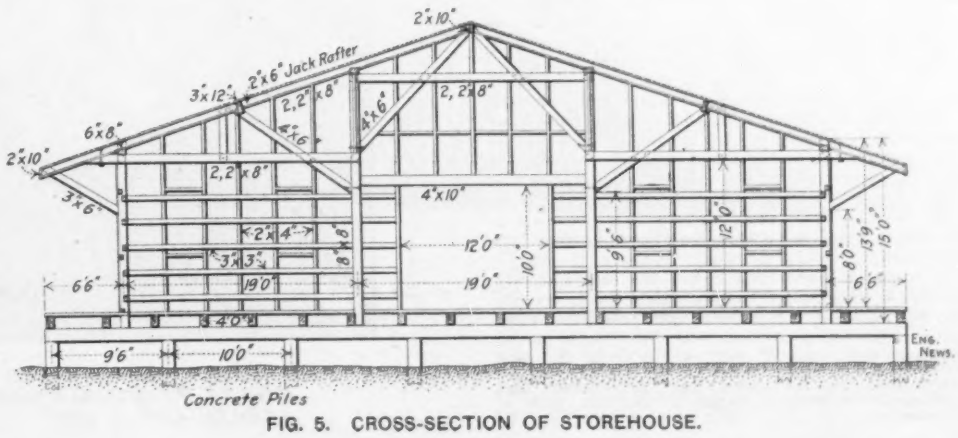


FIG. 5. CROSS-SECTION OF STOREHOUSE.

A SURFACE FINISH FOR CONCRETE.*

By Henry H. Quimby,† M. Am. Soc. C. E.

The concrete surfaces shown in the accompanying photographs are easily obtained. The process consists in completely flushing the face against the form, removing the form after the material has set but while it is still friable, and then immediately washing and rinsing the surface with water.

The washing removes the film of cement which has formed against the mold, and exposes the particles of sand and stone. The appearance then depends of course upon the character of the aggregate in the concrete and the uniformity of its distribution in the mixtures. As in well mixed concrete the cement merely fills the voids between the grains of sand, and the sand fills the voids between the pebbles or particles of crushed stone, the cement visible in this finished surface is so small a percentage that it has very little influence on the color of the work.

A convenient means of securing a well flushed front, uniform in texture is to make a fine concrete with the crushed stone or pebbles screened not to exceed say ⅜-in., and apply it to the face form with a trowel just in advance of the body concrete, and ram the concrete into it or joggle the two mixtures together so as to ensure an intimate union. This fine concrete, or granolithic mixture as it is generally called, may be made of different colored and different graded aggregates for different portions of a structure to compose a color scheme.

The appearance may also be controlled somewhat by

FIG. 1. CONCRETE COMPOSED OF 1 PART CEMENT, 2 PARTS YELLOW BANK SAND AND 3 PARTS ⅜-IN. SCREENED STONE. ACTUAL SIZE.

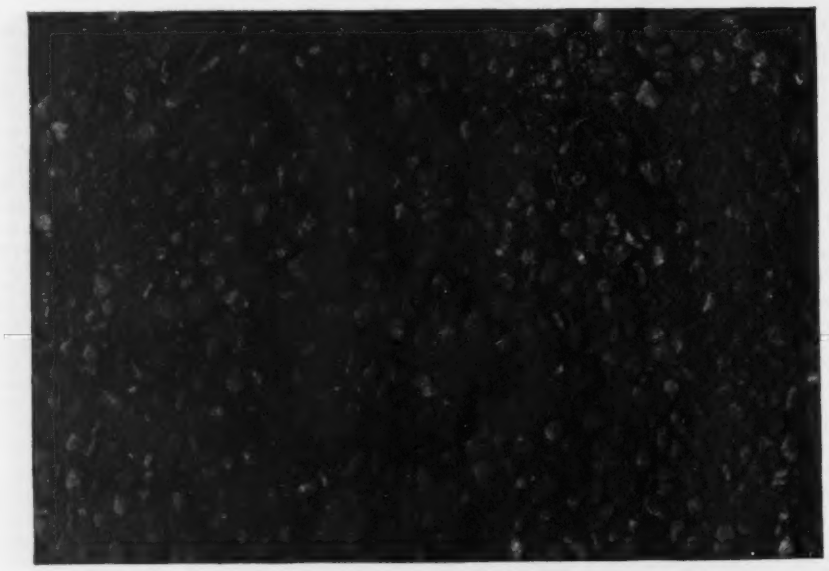


FIG. 2. PEBBLE AND SAND CONCRETE WITH SCRUBBED SURFACE COMPOSED OF 1 PART CEMENT, 2 PARTS BAR SAND AND 3 PARTS 3-16-IN. WHITE PEBBLES. ACTUAL SIZE.

the extent of the washing, for if the work be done at the right time the washing brush can be plied to remove the mortar to a considerable depth between the stones, leaving the stone in a very decided relief and producing a rough coarse texture which, by the way, seems to be the one most admired by the majority of observers.

The time to be allowed for setting before washing must be determined with regard to the nature of the cement used and to atmospheric conditions. Quick-setting cement and warm weather call for removal of form within eight or ten hours. The usual practice in summer, using almost any of the American Portland cements, is to remove the forms on the day following the deposit of the concrete. Of course this must not be done with the under or supporting portion of forms for arches and floors where the concrete is subject to stress, particularly in combination with reinforcement. Concrete that is sufficiently hard to sustain more compression than that due to the superimposed weight of a few of its own layers is too hard to wash. In cool weather when crystallization proceeds more slowly, the washing is practicable two or even three days after laying, and in cold weather a whole week has been found not too long to leave it in the forms when a slow-setting cement has been used.

If it should happen that a face has been permitted to become too hard for washing with a brush, the film can be rubbed off with a small block of wood or sandstone with a copious flow of water, but it is, of course, laborious and it cannot well be carried to the point of leaving the particles of aggregate in appreciable relief. The nearest approach to the washed surface is the effect produced by dressing with a sharp bush hammer and then washing with muriatic acid diluted one half. The acid should be well rinsed off.

If the height of the wall to be thus treated is too great to be completed in one day, face forms must be constructed to facilitate the removal of the planking without disturbing the studs or uprights. This is easily accomplished by setting the studs 8 ins. to 12 ins. away from the face line and supporting planks with cleats—say 2 x 1 in.—tacked to the studs and the planks. This permits the lower planks to be removed and the washing done while the upper planks are in place and concrete being deposited. With the exercise of very watchful care on the part of the workmen and unremitting inspection two different day's work can be joined so that after washing the joint will not be unsightly—even scarcely distinguishable, but such work is usually not obtainable throughout a structure. and it is found very easy to obtain thoroughly satisfactory joints by indenting horizontal grooves at regular intervals representing courses, and finishing each day's work at the apex of a groove. These indentations are made by means of triangular beads on the face forms. Usually the bead is the bevelled edge of a strip set between the face planks and lightly secured to the planks with partly driven toe nails so that, if desired, a plank can be removed independently of the bead above it, the bead remaining to set the plank upon the next course. These grooves in the face of a wall improve the appearance by relieving the blankness of a large area. It is found practicable

FIG. 3. SAND AND YELLOW PEBBLE CONCRETE COMPOSED OF 1 PART CEMENT, 2 PARTS BAR SAND AND 3 PARTS SCREENED YELLOW PEBBLES. ACTUAL SIZE.

*Reprinted from the "Cement Age" for November, 1906.

†Engineer of Bridges, Bureau of Surveys, City of Philadelphia.

to prosecute the work with one course of planks where the capacity of the plant for one day is equal to only one course of concrete. In this way the same planks have been used for many different courses on four or more different structures.

The cost of washing depends upon the degree of hardness obtained by the face. If it be taken at the right time three or four passages of an ordinary house scrubbing brush with a free flow of water from a hose or sponge will be all that is required, and a laborer should wash say 100 sq. ft. in an hour if the work is conveniently accessible. With a harder surface, such as it is likely to have within 24 hours in summer, scraping with a wire brush first will accelerate the washing which may then require from 2 to 5 hours for 100 sq. ft. Bush hammering will cost probably from 5 to 10 cts. per sq. ft. according to the quantity and the outfit.

This wash method of finishing has been in use for about three years, and the surfaces are quite as pleasing after the lapse of time as when fresh. As yet no hair or surface cracks have been found in any work that was washed, which is doubtless accounted for by the fact that the only material in which such cracks can develop is removed by the process.

A material advantage in the use of forms that are removable while the concrete is green is found in the opportunity for repairing blemishes. Incidental voids can be filled with the same material and bulges can be rubbed off because of its freshness without impairing the finish.

The accompanying illustrations are from photographs of specimens of various mixtures. The six cuts representing different mixtures as labeled show the actual size of the original.

It is important to direct the reader's attention to the fact in all of the concrete surfaces shown herewith the coarse aggregate projects in low relief. It may appear to one person in proper form while to another it may seem sunken or intaglio, as though the surface had formerly been incrusted with pebbles and sand, which had washed away. This is an optical illusion governed by the position of the light as it falls upon the page. If what are really crushed particles of stone or gravel in relief should appear as depressions, turn the picture upside down or in proper position to get the true impression.

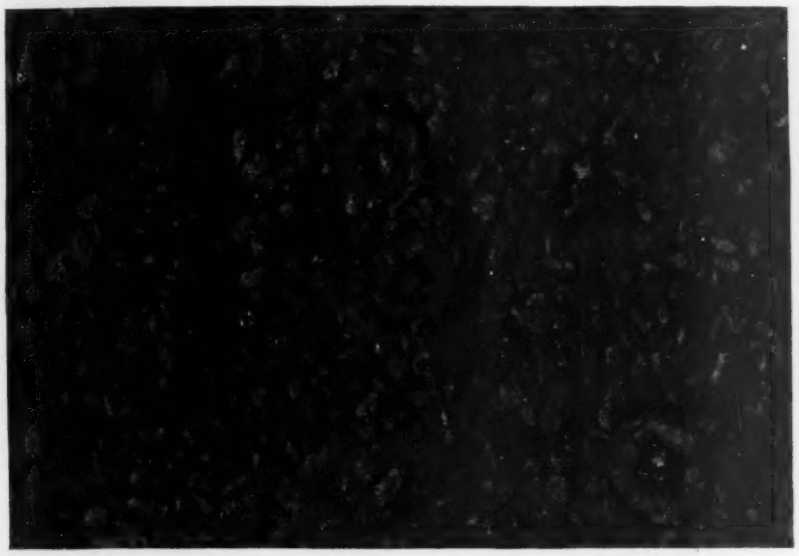


FIG. 4. GRANITE GRIT CONCRETE COMPOSED OF 1 PART CEMENT, 2 PARTS BAR SAND AND 3 PARTS ¼-IN. GRANITE GRIT. ACTUAL SIZE.

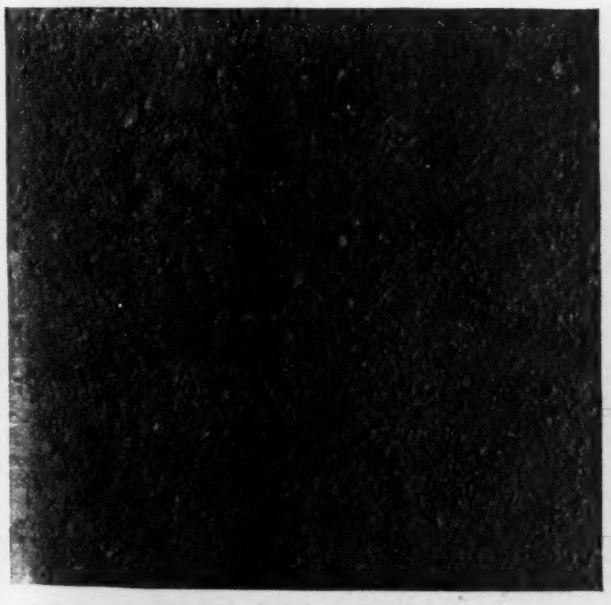


FIG. 5. CEMENT AND SAND MIXTURE COMPOSED OF 1 PART CEMENT AND 2 PARTS BAR SAND. ACTUAL SIZE.

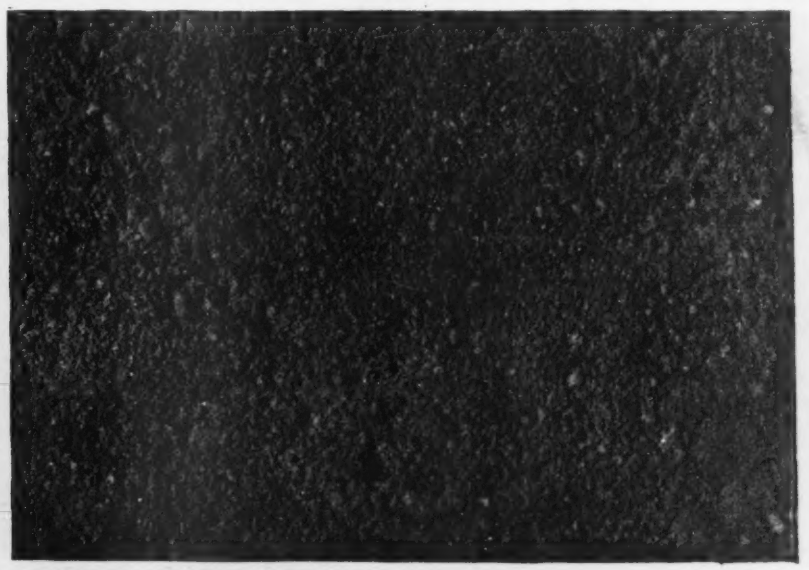


FIG. 6. YELLOW BAR SAND AND CEMENT COMPOSED OF 1 PART CEMENT AND 3 PARTS YELLOW BAR SAND. ACTUAL SIZE.

ALLOWABLE PRESSURES ON DEEP FOUNDATIONS.*

By Elmer Lawrence Corthell,† M. Inst. C. E.

In the year 1902 the author was chairman of a board appointed by the Argentine Government to consider and report upon propositions for the construction of a port at Rosario on the Parana River, 180 miles above the city of Buenos Ayres. The board consisted of seven members, all but one of whom were civil engineers. One of the subjects to which the attention of the board was directed was the allowable pressure upon the material carrying the deep foundations of the quay-walls which it was proposed to construct.

These foundations were to be carried down through the alluvions of the river, and were to rest upon the tertiary sand of the Parana River bed at depths ranging between 49.2 ft. and 71.1 ft below low-water level, the bed of the river being 21.3 ft. below low-water level.

The members of the board held very divergent opinions upon the question of the pressure which might be imposed on the foundations, the pressures recommended ranging between 2.7 tons* per square foot and 5 tons per square foot, while the contractor to whom the work was entrusted (Mr. Hersent, of Messrs. Hersent and Schneider) proposed to allow a pressure of 7.3 tons per sq. ft. upon the foundations.

The board finally decided upon a limit of 3.2 tons per sq. ft. The author, however, was not satisfied with this decision, and, by communicating with the members of the board individually, he found that a majority were of the opinion that 5 tons per sq. ft. would be quite safe, and in the contract for the work as finally arranged this pressure of 5 tons per sq. ft. was fixed upon as a maximum, with a mean of 3.34 tons per sq. ft.

The wide difference of opinion among experts, disclosed by this inquiry, caused the author to make further investigations, of which this paper is the result. A circular letter was addressed to about 300 engineers in various countries, asking them to contribute information on the subject, but only about 30 replies of any value were received. The author was assisted in the inquiry by Mr. C. R. Wychoff, who was also instructed by the author to make a thorough study of all published data on the subject and to collate the results.

The data which accompany this paper relate to 178 works. The deficient feature is the dearth of information in reference to pressures upon the material. The data also, do doubt, require to be corrected in some particulars, and it has been difficult to ascertain whether the pressures are maximum or mean, and also whether they include buoyancy of the surrounding water and the frictional resistance of the sides of the construction.

The author has made an analysis of these data and the result shows that the pressure of stable structures on the material upon which they are founded ranges between the following limits:

On fine sand, between 4,500 lbs. and 11,300 lbs. per sq. ft., with an average of 9,000 lbs. per sq. ft. in ten examples.

On coarse sand or gravel, between 4,800 lbs. and 15,500 lbs. per sq. ft., with an average of 10,200 lbs. per sq. ft. in 33 examples.

On sand and clay, between 5,000 lbs. and 17,000 lbs. per sq. ft., with an average of 9,800 lbs. per sq. ft. in ten examples.

On alluvium and silt, between 3,000 lbs. and 12,400 lbs. per sq. ft., with an average of 5,800 lbs. per sq. ft. in seven examples.

On hard clay, between 4,000 lbs. and 16,000 lbs. per sq. ft., with an average of 10,160 lbs. per sq. ft. in 16 examples.

On hard pan, between 6,000 lbs. and 24,000 lbs. per sq. ft., with an average of 17,400 lbs. and 24,000 lbs. per sq. ft. in five examples.

These cases show no settlement. The range is considerable and no doubt in the case of the minimum pressure a much larger weight could have been imposed on the material without producing settlement. For a safe rule, therefore, the average is low and a safe pressure upon the material would lie somewhere between the average and the maximum pressure.

Besides the foregoing cases the author found three

*Abstract of a paper presented to the Institution of Civil Engineers, of Great Britain.

†1 Nassau St., New York, N. Y.

*Throughout this Abstract the word "ton" means 2,240 lbs. In the original paper it is used to indicate the United States ton of 2,000 lbs.

instances in which notable settlement took place in fine sand, with a minimum load of 3,000 lbs. per sq. ft., a maximum load of 14,000 lbs. per sq. ft., and an average load of 10,400 lbs. per sq. ft. In clay, principally London clay, the author found five examples in which the pressure ranged betwen 9,000 lbs. and 11,200 lbs. per sq. ft., with an average of 10,400 lbs. per sq. ft. In silt and alluvium two cases of settlement were reported, with loads of 3,200 lbs. per sq. ft. and 15,200 lbs. per sq. ft.—a wide variation. Three cases of failure on a mixture of sand and clay are given, the pressures ranging between 3,200 lbs. and 14,800 lbs. per sq. ft., with an average of 6,000 lbs. per sq. ft. This should be compared with the average of 9,800 lbs. per sq. ft. and range of 5,000 lbs. to 17,000 lbs. per sq. ft. in ten examples already referred to, in which no settlement occurred.

Records of frictional resistance are also very variable. In ten cases of cylinder-piers the average was 540 lbs. per sq. ft., the resistances ranging between 300 lbs. and 1,500 lbs. per sq. ft., gravel showing the greatest resistance (1,500 lbs. per sq. ft.) and mud the least. In 23 masonry-piers the frictional resistance ranged between 300 lbs. per sq. ft. in sand and gravel, and 1,000 lbs. per sq. ft. in sand and clay, with an average of 522 lbs. per sq. ft.

TESTS OF THE BOND BETWEEN CONCRETE AND STEEL IN REINFORCED CONCRETE.

A paper on the above subject by Mr. T. L. Condron, was presented at a recent meeting of the Western Society of Engineers, Chicago, and was accompanied by a report of tests made by Prof. C. E. De Puy, Professor of Mechanical Engineering at Lewis Institute, Chicago. The paper opened with a statement of the lack of uniformity in the results of many recorded tests, as indicated below, the figures giving the minimum and maximum adhesion per sq. in. of the embedded surface of plain, round and square bars:

	lbs. per sq. in.
Zeitschrift des Vereins Deutcher Ingenieure (Vol. 49, '05) "Cement Age," Oct., 1905....	93 to 592
E. Morsh (From "Beton und Eisen," 1903)....	100 to 696
E. S. Wheeler, U. S. Assistant Engineer ...	111 to 556
Prof. A. N. Talbot, University of Illinois.....	174 to 386
Prof. C. E. DePuy, Lewis Institute.....	188 to 341
Prof. C. W. Spofford, Mass. Institute of Technology	219 to 374
S. W. Emerson, Case School of Applied Science	278 to 587
Prof. F. H. Constant, University of Minnesota	316 to 854
Prof. W. K. Hatt, Purdue University.....	470 to 756
Prof. Bauschinger (From Buel & Hill's "Reinforced Concrete")	570 to 640

The strength of the bond or adhesion was stated by Mr. Condron to depend upon the following factors, any or all of which may vary:

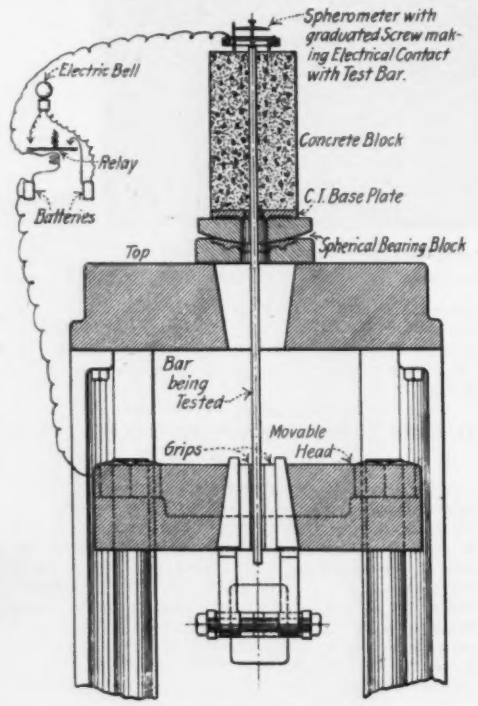
Quality of cement; character of sand or stone dust used in the mortar; ratio of cement to sand or stone dust; sizes of gravel or broken stone used in concrete; ratio of mortar to gravel or broken stone; degree of plasticity or percentage of water used in mixing mortar and concrete; thoroughness of mixing process; care with which mortar or concrete is placed; amount of leakage of mortar from concrete because of defective forms; possible disturbance of concrete during time of setting; breaking the initial adhesion to bars (this may easily result from tamping on or near concrete that has taken its initial set); the condition of the surface of the bars; and the age of the concrete.

It also stated that a French engineer, Mr. Breuille, in 1902, reported that the bond is reduced from 50 to 66% after the immersion of reinforced concrete in water for nine months, while in time the adhesion would be entirely destroyed as the result of the action of the moisture. This, of course would be important in structures continuously exposed to the action of water.

A feature of the report of Prof. De Puy's tests is that they indicate how much the bars slip before the maximum load is reached, which is an important feature to be considered in tests of the strength of bond. The tests were made with bars of different forms embedded for different lengths in blocks of concrete made of a fairly wet mixture of Portland cement, sand and broken limestone (¼-in. and under, without dust) in proportions of 1:2:4. The blocks were 6 ins. diameter and 8 to 24 ins. long, and those of the tests noted in Table II. were 31 days old. The apparatus used is shown in the accompanying cut, and is described by Prof. De Puy as follows:

Each concrete block had a cast-iron base plate, and was supported upon a spherical bearing block on the top of an Olsen testing machine so that the specimen could be properly adjusted from a direct pull on the bars. The lower projecting end of the bar was gripped into the movable head of the testing machine. The upper end of the bar projected ¾-in. above the top of the block, while upon the concrete block rested a spherometer with the graduated screw brought into contact with the upper end of the bar being tested, thus closing an electric circuit. As the load came on, the slightest slipping of the bar in the concrete would break the electric circuit, causing a bell to ring until the graduated screw was turned down and the circuit closed. By this means it was possible to measure very accurately the movement of the bars and the load causing the same.

The accompanying tables give a summary of the tabluations of tests which are given with Prof. De Puy's report. Table I. shows the particulars of the bars and also the relative strength of the bond in each case; these latter figures express the relative efficiencies of the different bars at the point where the slip did not exceed 0.01 in., taking the bond of the plain round bar as unity. In Table II. are shown the stresses in the bars per sq. in. of cross section and of embedded area; these last figures, however, are not shown for the Thacher bars, as their areas could not be readily determined.



Apparatus for Testing the Bond Between Concrete and Steel.

Table I.—Relative Efficiency of the Bond with Various Bars.

	Size, ins.	Wt. per ft., lbs.	Ave. area, sq. ins.	Relative efficiency embedded, 8 ins.	24 ins.	Ave.
Round	11/16	1.284	0.378	1.00	1.00	1.00
Square	5/8	1.322	0.390	1.30	1.42	1.23
Twisted* (B) ..	5/8	1.343	0.395	1.38	1.79	1.53
Twisted* (R) ..	5/8	1.345	0.395	2.11	2.04	1.70
Thacher	3/4	1.310	0.385	2.75	2.30	2.22
Corrugated† (N)	3/4	1.250	0.368	2.60	3.00	2.70
Corrugated† (O)	3/4	1.443	0.424	3.18	3.18	2.95

*Twisted bars; B, Buffalo Steel Co., 2.3 twists per ft.; R. Ransome Co., 2.8 twists per ft.
†Corrugated bars: N, new style; O, old style.

TABLE II.—RESULTS OF TESTS OF BOND OF BARS EMBEDDED IN CONCRETE (CONCRETE 31 DAYS OLD).

Embedment	Stress per square inch of cross section—Slip not more than: 0.01-in. 12 ins. lbs.	0.01-in. 24 ins. lbs.	1-32-in. 12 ins. lbs.	1-32-in. 24 ins. lbs.	Stress per sq. in. of embedded area. Slip not more than: 0.01-in. 12 ins. lbs.	0.01-in. 24 ins. lbs.	1-32-in. 12 ins. lbs.	1-32-in. 24 ins. lbs.
Round	18,700	24,800	20,100*	26,500*	269	178	289*	190*
Square	24,300	35,200	26,200*	37,300*	316	229	341*	242*
Twisted (Buff.)	25,400	44,300	27,100	46,700	334	291	357	306
Twisted (Ran.)	24,600	50,600	27,800	53,400	324	332	366	350
Thacher	40,800	57,100	46,600*	57,100*	...	...	...	...
Corrugated (N)	37,500	74,500	48,400	80,000*	474	471	612	506
Corrugated (O)	48,000	79,000	58,000	79,000*	651	535	785	535

*Developed full strength of bond before slipping 1-32-in.

AN ELABORATE SYSTEM OF SEWAGE PURIFICATION AT STRATFORD-ON-AVON.

Hereafter engineers visiting England will have, in addition to the usual reason for visiting Stratford-on-Avon, the opportunity to inspect a small but elaborate modern sewage disposal works. The plant includes liquefying (septic?) tanks, percolating filters, land filters, and final land treatment or broad irrigation, in the order named. This is for the dry weather flow and for two volumes additional of storm flow. Three additional volumes of storm flow will be partially purified on contact beds without previous treatment.

Litigation over an alleged nuisance caused by the old sewage works at this place led the municipality to retain Messrs. Willcox and Raikes, civil engineers of Westminster and Birmingham, to design new works. The site chosen was 17 acres in area, of such contours as to permit the construction of works on three levels. The site is close to the river into which the effluent is discharged. Application for approval of a loan and the plans for the work was made to the Local Government Board in January, 1904, and the approval having been secured detail plans were prepared. Construction was begun in September, 1904, and the new works were opened a short time ago. The dry weather sewage flow, including trade wastes, was considered as being 300,000 U. S. gals. per day. Three sets of pumps, each with a capacity of twice the dry weather flow, were provided, and a 15-in. force main with a total lift of about 100 ft. was constructed.

The liquefying tanks and storm water contact beds are located on the first or upper terrace; four percolating filters are located on the second terrace; another four percolating filters, and the land filters, are placed on the third or last terrace.

Each of the four open liquefying tanks is 25 x 102 ft., x 6 ft. deep, and the four tanks together have a holding capacity of 450,000 U. S. gals., or 1½ times the dry weather flow. In order to retain as much of the sludge as possible at the inlet end of the tanks, a cross-wall extending nearly to the water level is provided, 15 ft. distant from the inlets. These tanks have brick side walls laid in cement, and floors of brick placed on edge on concrete foundation with a shallow sludge channel running down the center of each tank.

Each of the eight percolating filters is 85 ft. in diameter and 5 ft. deep. The total area of these filters is 1.033 acres, and as they are designed to treat a dry weather flow of 300,000 gals. per acre, this gives a daily rate of about that amount per acre, but the maximum rate, in time of storms, will be nominally 900,000 gals. per acre. The sewage is distributed by means of revolving radial sprinklers, working on ball bearings.

There are eight land filters with a total area of about two acres, which, it appears, are similar to the intermittent filters extensively used in the United States.

The irrigation area includes about 10 acres of gravelly soil, underdrained by 4-in. tile, 4½ ft. deep, 66 ft. c. to c. The storm water contact beds, four in number, are 50 x 67 ft. in plan, giving a total area of 0.3 acre, and are 3¼ ft. in depth. Like the percolating filters, these are composed of clinkers. The contact beds are fed and discharged by means of automatic siphons. When working at their full capacity of three times the dry weather flow, or 900,000 gals. per 24 hours, the rate of treatment per acre per day will be 3,000,000 gals. It is proposed to provide an acre of land for digging in the sludge from the liquefying tanks.

The complete works were built within the estimated cost of £23,500 ($114,000). Whether this figure includes the cost of the 17 acres of land, right-of-way for the force main, engineering and legal expenses, we cannot state. For the foregoing information we are indebted to our London contemporary, "The Surveyor and Municipal and County Engineer" of Nov. 9, 1906.

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Entered at the New York Post-Office as Second-Class Matter.

The most useful paper on concrete ever printed in an engineering journal, we believe, is that contributed by Mr. W. J. Douglas, Bridge Engineer of the District of Columbia, to this issue of Engineering News.

The paper represents the fruit of Mr. Douglas' practical experience for several years past in the handling of concrete work. There are, perhaps, a few engineers and contractors who have acquired such familiarity with concrete work that they know already everything which Mr. Douglas has set down, but we believe they are very few. The great majority of those who are doing concrete work do not know it all yet by a good deal, and welcome, we are sure, every opportunity to learn from the practical experience of others.

There used to be a prevalent impression that anybody could do concrete work. One still finds local contractors who have laid cellar bottoms and sidewalks who believe themselves competent to undertake any sort of work with cement. The Portland cement now on the market is so strong and reliable and stands so much abuse that one often finds these little contractors of limited experience confident that they can mix cement with any old material—dirt, ashes and what not—and handle it any old way, and the resulting compound will be "hard as a rock."

Perhaps there were ideas of this sort among engineers a few years ago, but we believe they are now largely dispelled. It is pretty well understood now that concrete work demands skilled workmen, if good results are to be produced. A contracting firm which can build up a reputation for producing good and safe concrete structures of pleasing appearance has a business which is far more valuable than anyone supposed would be the case a few years ago. Engineers and architects appreciate now, as they did not then, the value of a contractor with such a reputation in comparison with another bidder who has his experience still to gain, and who will gain it at the expense of his employer.

We have discussed in a recent issue the matter of safety in concrete construction. The task of securing a pleasing appearance to concrete work is even more difficult than the matter of safety. We reveal no secrets when we say that a good-looking concrete bridge or building is the rare exception. How to secure a decent surface finish to concrete? That is the unsolved problem today—unsolved at least so far as the great bulk of engineers and architects and contractors are concerned. As the reader will observe, Mr. Douglas' notes relate even more to this matter than to the matter of strength. While he does not pretend to give a recipe which will enable anyone to produce a good surface finish on concrete work, he does point out many pitfalls into which the inexperienced may fall, and he does show the general direction one must follow to reach the desired end.

Useful information on this subject also is given in the paper by Mr. Quimby, of Philadelphia, also printed in this issue. We believe that Mr. Quimby's method of washing the surface of concrete to remove the cement and expose the clean faces of the aggregate has large possibilities of development.

It occurs to us to suggest that some of the numerous cement laboratories in the engineering schools should undertake experiments on the surface finish of concrete, instead of threshing over more or less old straw in tests of strength. Engineers and contractors and owners are too busy to make such experiments, even in promising directions. There are a lot of possibilities in concrete work that ought to be tried out. For example, we know of some exceedingly satisfactory concrete work which has been given a dash coat or stucco finish with a mixture of cement, sand and lime. While engineers and architects are afraid of this finish, the fact remains that success has been and can be achieved with it; but the work must be done in the right way. There are large possibilities, too, in securing ornamental effects by the use of different aggregates. Nothing can be done commercially in this way now, because materials are not on the market. One has to use such sand and stone or gravel as the local market will furnish. But it ought to be possible to procure sand of a dozen shades of color from pure white through a large range of reds and browns and yellows. Gravel and broken stone of varying colors and sizes ought also to be on the market, and would be as soon as the demand for it was found. The possibility of coloring cement without seriously injuring its strength is another matter which should be further investigated.

A closely related subject is the matter of efflorescence and how to prevent it or to get rid of it when encountered, and this leads directly to the subject of waterproofing methods suitable for use on a surface exposed to view.

Years hence engineers and architects will have learned how to do a lot of things with concrete that are now impracticable. Years hence people will wonder why such ugly pieces of concrete work were perpetrated when a little knowing how would have produced a thing of real beauty. It will be thought strange that the early workers in concrete seemed to do nothing but try unsuccessfully to imitate stone or else covered up the concrete with a veneer of some other material, using even flimsy and shortlived sheet metal, in evident despair of producing any decent appearance with concrete itself.

Among the arts yet to be developed in America, or at least put in practice, is that of city planning. In nearly every case where a city map shows that a street plan has been followed the streets are on the rectangular system, with little regard for variations in density of traffic and with few or no modifications to suit the topography, unless the latter is so rough as to force such modifications. Where so little attention is paid to utility it is not surprising that esthetic considerations are almost entirely ignored, a street on a river's bank being a street and nothing more. There are, fortunately, some notable exceptions in the way of street esthetics, but for the most part these are such elementary and obvious accessories after the fact as tree planting, and perhaps further embellishments in the way of shrubs and flower beds. Street esthetics should go further, and include, where possible, grades and alinements, open places, vistas and proper objects to emphasize their termination; and last but not least, the facades and skylines of the buildings lining the streets. How far all this is from American conditions and how common to many continental European cities many of our readers know.

Most of our city planning has been of a haphazard character, and wholly under the control of various real estate owners. In the older cities, or at least their built-up portions, this cannot now be helped, or can be remedied only at great expense, but the newer towns and the undeveloped sections of all cities might be laid out with an idea to utilitarian and esthetic needs hardly more than dreamed of in this country as yet. Fortunately, there are individuals and organizations in some American cities that are devoting time and thought to these matters. One of the grandest opportunities for modifying street plans to utilitarian and esthetic ends now exists in the Borough of the Bronx, New York City. The Municipal Art Society of New York (119 E. 19th st.) has recently issued a bulletin on the opportunities of the Bronx. It points out the harmful effect of substituting sectional real estate street plans for the previously-adopted street plan for the whole territory, and discusses the needs of the borough in the way of developing and making accessible its already grand park system.

That they do these things better in Germany than in either the United States or Great Britain is the opinion of the author of a paper read only Nov. 16 before the Association of Municipal and County Engineers, at Westminster, England. The paper, on "The Planning and Control of Town Extensions in Germany," strikes us as so valuable that we print it in full elsewhere in this issue. We make no further comments on the paper, hoping that those at all interested in the subject, and they should be many, will turn to the paper for a knowledge of its many interesting points.

We received last week the following bulletin from the Department of Agriculture:

UNITED STATES DEPARTMENT OF AGRICULTURE.
FOREST SERVICE.

Trade Bulletin 11. No publication before Dec. 20, 1906.

RESISTANCE OF WOOD TO SHOCK.

Little study has been given to the resistance of wood to the action of impact loads, such as result when a locomotive passes over a wooden trestle. The Forest Service has been studying the subject at the timber-testing station at Purdue University, Lafayette, Ind., and finds that wood is more elastic under impact than under gradually applied loads. This would go to show the wisdom of locomotive engineers in taking a weakened trestle at high speed.

If there are any locomotive engineers whose "wisdom" takes the form of running at high speed over a weakened trestle, we hope the writer of the above bulletin may be the one to ride behind! If a trestle is "weakened" so that there is any doubt whether it will stand up or not, the locomotive engineer who runs across it at all, let alone running across it at high speed, is taking serious chances. Of course, there are cases where a structure is undergoing repairs or where temporary trestles are put in around breaks where a structure is safe enough to crawl over at three or four miles per hour. No one but an insane man would run over such a structure at high speed, as is suggested above.

It may be of interest to see what the tests were which led to this remarkable conclusion. Examination shows that they were cross-bending tests of 2 × 2-in. beams with a span of 34 ins. The results of the test are summarized as follows:

The maximum deflection under a gradually applied load was 1.2 ins., and the deflection just preceding failure under impact was 1.1 ins. There is, thus, little difference between the ultimate deflection of wood under the two kinds of loading. But at the elastic limit the average deflection under gradual loading was 0.33-in., while the average deflection under impact loading was 0.66-in. Thus this wood possesses twice the elastic strength under impact that it does under static load.

So it appears the compiler of this bulletin thinks the stresses produced in a railway trestle by the passage of a train at high speed are comparable to those set up in his impact tests! He had better think some more. It is always commendable to try and draw practical lessons from theoretical researches, but the deductions must be made with the aid of common sense.

Without that useful part of the mental equipment, one reaches such ideas as that which a German scientist seriously put forward a few

months ago in one of our foreign exchanges. He proposed to build bridges with an exaggerated camber of circular form, so that the centrifugal force of the train passing over the vertical curve would take part of its weight off the bridge!

THE SEWAGE DISPOSAL PROBLEM OF METROPOLITAN NEW YORK AND NEW JERSEY.

The proper disposal of the sewage of the 5,000,000 people within the metropolitan district of New York is a problem both unique and stupendous. Two sovereign states, many communities, numerous bodies of tidal water (all finally merging into one, of enormous aggregate volume), extensive shellfish and enormous boating and shipping interests, and hundreds of miles of docks, beaches and other shore lines are involved. And yet the communities indicated have attained a combined population of 5,000,000, almost without a thought as to the effect of discharging their crude sewage into the nearest available body of water: the exceptions being the two groups of inland communities on the Passaic and the Bronx rivers, respectively, and scattered groups of population in the Long Island portion of Greater New York. A few relatively small sewage works, treating altogether the sewage from perhaps 100,000 people have been built; some of these have been abandoned, others have been partly abandoned, and none of any size is effecting a high degree of purification to-day.

Perhaps the most remarkable feature of sewage disposal in the New York metropolitan district is that, outside certain inland sections, so little nuisance has arisen from discharging the sewage into the nearest tidal waters, especially where a little care has been taken to extend outlets to deep, moving water. That there has not been more nuisance has been due to luck rather than to forethought; or if not to luck, then to a huge volume of water, distributed along an immense water front, thus favoring disposal by dilution at numerous points. As is well known, disposal by dilution is not only a legitimate but also one of the best possible means of sewage disposal, when local conditions are favorable.

At the present time it is estimated that the sewage of about 4,500,000 pepole is discharged by New York City, Hoboken, Jersey City and Bayonne into the East and North rivers and New York Bay. This has been going on, only of course from smaller populations, ever since sewers existed, and with no protest of moment, so far as the main discharge is concerned. How much longer it might have continued without protest had not the Passaic and the Bronx valley sewers been projected no one can say, but the proposition to increase the sewage which the millions of Greater New York contribute to the bay by the sewage from a few hundred thousands living to the west and north of New York City, has given rise to a few storms of protest, some of which have been violent. Far be it from us to say that this is unnatural or inexcusable, but we do urge a broad, dispassionate consideration of the whole subject, and a neighborly one, withal. Instead of taking the ground that no other communities should be allowed the sewage disposal facilities which New York Bay affords, and which some millions of the people bordering on it are already enjoying, or of taking the even more radical ground that *all* crude sewage should be excluded from the bay, a thoroughgoing scientific investigation of the whole subject of sewage disposal by dilution in New York Bay should be made, preferably in the joint interests of all the New York and New Jersey communities affected. The first objects of such an investigation should be to establish conclusively the volumes of sewage now being discharged at various points and the volumes of diluting water at those points; the effect of the sewage upon the water at the surface and at various depths, for various distances from each outlet; the movements of tides and currents, both as to volume and direction, in relation to the several outlets or groups of outlets. These questions answered, as well as others that would arise while the investigations suggested were being made, it would then be possible to forecast the likelihood of nuisance at various points and in the bay as a whole; whereupon (and not before) can there be a rational discussion of possible remedial measures. Even when probable future nuisances and their possible remedies have been determined a final conclusion as to the wisdom of preventive measures cannot be reached until the cost and the benefits flowing from improved means of sewage disposal have been balanced against the benefits to be derived from the many other public improvements that are always awaiting authorization and funds in great centers of population. There may be a dozen projected improvements far more important to the health and convenience of the metropolitan district than any immediate radical change in methods of sewage disposal. It is for expert investigatators to determine just what changes, if any, in sewage disposal are demanded now or will probably be demanded in the near future, and what the cost of such changes would probably be. With such information before them the municipal and state authorities, and the general public, would be in a position to judge whether and how soon money should be spent on extending sewage outfalls and perhaps on treating the sewage of portions of the metropolitan district.

Before proceeding further let us examine the nature of the protests that have been made thus far against sewage disposal into the waters adjacent to New York. As we have already stated, these protests chiefly relate, not to the sewage of 4,500,000 now going into those waters, but to the proposed addition of the sewage of a few hundred thousand people in the Passaic and in the Bronx valleys. The Passaic outlet would be at Robbins Reef, New York Bay, and the Bronx outlet would be on the Hudson River, near the boundary line between New York City and Yonkers. These proposed outlets, strange to say, are the only important ones in the metropolitan district that have been chosen in the light of expert study as to their effect on the waters into which they were designed to discharge. The protestants fall into two classes: (1) those who selfishly oppose the repetition of their own acts by others; and (2) those who demand far-reaching, all-inclusive remedial measures. It is unnecessary to discuss the reasoning or selfishness of the first class, unless there be some reason unknown to us why New York City, Hoboken, Jersey City and Bayonne should have a sewage-outlet monopoly on the tidal waters surrounding them. The other class of protestants is most certainly entitled to a hearing. Its members ought not, however, to settle the whole question off-hand, by a priori reasoning to the effect that all waters, tidal or fresh, should be kept in the same condition when millions of peoples live on their shores as when only a few small bands of Indians roamed along their wooded banks.

People who live in cities must pay many penalties therefor; lack of elbow room everywhere, whether sitting, walking or riding; dust and perchance odors in the air; all-pervading noises; blue skies obstructed, sometimes by smoke, sometimes by skyscrapers; walls and pavements in place of trees and green fields, and more or less polluted and dull instead of pellucid and sparkling surrounding bodies of water. It is the bounden duty of municipal authorities to ameliorate these unfortunate conditions so far as physical and financial limitations will permit, having regard for health first, comfort and general convenience next; but always with a proper perspective of the relative importance of each and every municipal need. This duty, we hardly need say, is rarely fulfilled. A narrow-sighted policy, prejudice, a too open ear for the special pleading of some particularly well-voiced interest, either public or private, and, worst of all, the helpless blindness of sheer ignorance, are always at work, singly or in combination, to further some public improvement to the neglect of some other, or perhaps all others. In the case of sewage disposal at New York and vicinity, a long period of neglect is now followed by a period of interest. This may prove long or short, but thus far it has been characterized, for the most part, more by selfishness, prejudice and ignorance than other qualities.

A rational view of sewage disposal in the North and East rivers and in New York Bay is greatly needed. It must be recognized first of all, that there are only two ultimate means of sewage disposal: onto land and into water, and that eventually the liquid portion of sewage must find its way into water, accompanied by more or less of its solid contents, the proportion depending upon conditions varying with each locality—this last being true even if some of the solid matter be artificially removed. The metropolitan district is surrounded by an abundance of water eminently suited to sewage disposal, but not by land available for that purpose. The water not being used for drinking purposes, and the shellfish industries which the water supports being of such minor importance, compared with the cost of distant means of sewage disposal, as to warrant their purchase and abandonment, if need be, there is no reason why the sewage of the district should not be discharged into salt water, provided: (1) the outlets be so located as to avoid nuisance at piers and on beaches; and (2) that the amount of sewage discharged at any one point, and into the waters as a whole, be not in excess of the capacity of those waters to dilute, diffuse and oxidize the sewage so as to prevent disagreeable odors, or serious fouling of the water surface. To purify the sewage of the whole metropolitan district, or to convey it into the ocean beyond New York Bay, would involve an enormous expense, incommensurate, as yet, with any possible resulting benefit. The time may come when a considerable portion of the sewage of the district may have to be treated, the treatment ranging all the way from rough screening to the removal of a large percentage of the organic contents, depending upon local conditions in the vicinity of the various outfalls. Just what the probable needs of the future are should be determined as soon as possible, in order that all future sewage construction and sewage disposal may be governed accordingly. No safe conclusions can be expected without the thorough, impartial, scientific study of the whole subject that has already been advocated in this article. As we see it, the study is demanded more in the interests of the future than of the present, and its need is made pressing just now by the agitation over the Passaic and Bronx projects.

Thus far our discussion has proceeded as though no study of water pollution at New York had been made and no means were at hand for continuing such studies. This is not the case, although the investigations now to be mentioned have been limited in scope through lack of adequate funds and also because conducted almost wholly by representatives of Greater New York, and with no representation of and naturally little concern for the interests of the New Jersey communities. The New York Bay Pollution Commission, whose first report was abstracted at length in our issue of May 4, 1905, and whose second and final report has just been printed, was appointed in 1903, by authority of the New York legislature, to investigate "the threatened pollution of the waters of New York Bay." Although having and exercising power to consider pollution from any source the commission was called into existence by the proposed Passaic Valley sewer outlet in New York Bay. This was the burden of its first report, the conclusion of which was against the outlet, and in favor of a broader and more extended study of the pollution of the bay than was possible in the first instance. The second report is almost wholly the work of Dr. Geo. A. Soper, M. Am. Soc. C. E., who was constituted a special committee on chemical and bacterial studies and physical inspection of the waters of the bay. A total of 115 analyses, both chemical and bacterial, were made under Dr. Soper's direction, as well as a sanitary patrol of many

nuisances of shore line. Dr. Soper's general conclusions were as follows:

(1) The waters of the bay and adjacent waters are unmistakably, but not as yet badly, polluted.

(2) The sewage is not uniformly dispersed and diffused throughout the depth and breadth of the tidal currents. The discharge of crude sewage results in polluting the water more at the surface than in the depths below.

(3) The discharge of sewage along the shores often leads to the production of a decided local nuisance.

(4) Although the present method of disposing of the sewage of Manhattan is, perhaps, as acceptable as any method of emptying crude sewage into these waters could be, it is far from being always satisfactory.

(5) The disposal of sewage at the pierhead line, as practiced on Manhattan Island, is much to be preferred to the plan of emptying it at the bulkhead line as is generally practiced elsewhere in this vicinity.

(6) There is no doubt but that offensive matters from the sewage, and the sewage itself, are sometimes transported long distances by the tides and winds and deposited on shores remote from any sewer outlet.

(7) Excepting in such heavily polluted waters as Gowanus Canal, there is probably always enough oxygen in the water to enable the bacteria of decomposition to carry on their work without the production of offensive odors.

(8) No other method of disposing of the sewage of New York and vicinity is suggested as the result of these investigations. It is evident that some other method should be devised, if practicable, but the satisfactory study of this question involves investigations of a far more exhaustive character and of a wider scope than have thus far been possible.

It will be seen that these conclusions show no cause for immediate alarm, but indicate that minor and chiefly local pollution already exists and must become worse with the growth of population. They also point out the need of "far more exhaustive" investigations before an attempt is made to suggest a substitute method of sewage disposal for New York and vicinity. A reading of the whole report, together with the one made last year, confirms Dr. Soper's statements as to the inadequateness of the data thus far obtained and the desirability of adding thereto.

In recognition of the need for further and broader study the New York legislature of 1906 provided for a Metropolitan Sewerage Commission, which has since been appointed. The new commission is authorized to cooperate with any similar body acting in behalf of New Jersey, but thus far the New Jersey State Sewerage Commission has not responded to an invitation to cooperate with the New York Commission. Why it fails to do so we cannot say, but we may state, what is not generally known, that the New Jersey Sewerage Commission has no control of the Passaic Valley scheme, or of sewage disposal into the tide waters of New Jersey.

For some three years the New York Bay Pollution Commission had the stage to itself. Now comes the Merchants Association of New York with a "Committee on Pollution of the Waters of the State of New York." As this committee, if we are correctly informed, has not yet had a meeting, its plan of action cannot be stated. Evidence is at hand that it is to put itself on the side of those who oppose the discharge of any sewage into the waters adjacent to New York City. The Merchants Association as a body and through a committee might contribute greatly to a rational effort for the conservation of the purity of the natural waters of New York City and State. What is most needed from the Merchants Association and other bodies designed to promote the public good is intelligent support of existing agencies for the study of water pollution, like the present Metropolitan Sewerage Commission, the New York State Department of Health and the U. S. Geological Survey. All these duly constituted agencies are in need of and deserve better support, both moral and financial. The State Department of Health, although on a much better footing than formerly, is in need of more money to carry on much-needed work and of more authority to enforce its rulings. For many years municipalities have been compelled to submit sewage disposal plans to the department for approval. The approval given or refused that, apparently, has been the end of it. Why? Because neither authority or money were available to make sure that the plans approved were ever carried out.

But to return to our specific subject. Further and more adequate investigations are essential before anyone can say just what should or should not be done with the sewage of the New York metropolitan district. To sum up, there remain to be shown: What is the capacity of New York Bay for sewage disposal by dilution, and when is that capacity likely to be reached? What methods are available and what would be the cost of remedying such local nuisances as already exist, and likewise what methods could be employed to effect a wholesale change in the sewage disposal of the whole metropolitan district, and what would be the cost of so stupendous an undertaking? Has the metropolitan district more immediate and vital problems than sewage disposal, and if so what would their solution bring in the way of health-protection, comfort and convenience, as compared with the like effects of a radical change in the sewage disposal methods of the whole district?

LETTERS TO THE EDITOR.

More Concerning the Corrosion of Steel Imbedded in Cinder Concrete.

Sir: In your issue of Nov. 22 you added a few comments after my communication on the subject of the corrosion of steel imbedded in concrete.

The statement in the first paragraph of your comments is only partly correct, as a portion of the sulphur included in the sulphuric acid of the Portland cement is free calcium sulphate, which is known to have a corrosive effect on steel. (See Journal of the American Chemical Society, June, 1903).

I would have referred more in detail to the sulphuric acid in the cement, but presumed that most of your readers were thoroughly familiar with the chemical properties of Portland cement.

In explanation of the 3% which was given for the total sulphur in the Portland cement, I would state that in the tests of cinder concrete which were made in 1898, an imported brand of Portland cement was used that ran unusually low in magnesia and had a trifle over 2½% of sulphuric acid, this particular cement being used on account of its superior fire and water resisting qualities.

The statement that you make in the second paragraph of your comments, to the effect that the sulphur is unequally distributed in the cinder, and that a chance lump of pyrites in the coal may result in a lump of clinker high in sulphur in the ash, is erroneous. It is a matter of record as the result of careful investigation and numerous analyses of cinder that the amount of sulphur in the form of free sulphuric acid and sulphides is remarkably uniform and varies slightly only with different grades of coal and different temperatures obtained during combustion. No matter how irregularly the sulphur may be distributed through the coal, it is, during combustion, largely vaporized, and the entire mass being very uniformly impregnated with the fumes, retains only a relatively small amount of sulphur uniformly distributed in the residue or cinders.

The actual amount of sulphur in thirteen samples of cinder as it came from the boilers of the New York Steam Co. in 1898, averaged 0.213 of 1% of sulphuric acid and 0.188 of 1% of sulphur as sulphides; the individual samples varying less than 10% from the average. As explained in my former communication, this small amount of sulphur is neutralized many times over by the Portland cement when made into concrete.

Very truly yours.

A. L. A. Himmelwright.

Fuller Building, New York, Dec. 7, 1906.

"The Lesson from Recent Failures of Reinforced Concrete Structures."

Sir: In a former issue of "Cement Age" the editor said that reinforced concrete construction would be damned by its fool friends.

Analyzing one of the letters published in your last issue and dated at 1 Madison Avenue, I find:

1. Owner bought material.
2. Material inspected by contractor's employees and owner's agents.
3. Skinning: None either in design, material or workmanship.
4. Inspection: Best talent possible regardless of expense.
5. Watchful eye not lacking: Owner's own inspector constantly on work; in addition to several engineers who spent their entire time in general supervision of the contractor's operations.
6. Not possible therefore that concrete work should ever receive more careful inspection, both from owner and contractor, than in this particular work.

Result: Disastrous failure with a list of dead and injured.

Query: Given first-class material; careful design; first-class inspection and best of workmanship; yet despite all these—disastrous failure—would your classification DANGEROUS not be justified?

Surely the "reductio ad absurdum" is reached when that writer refers you to the deaths in the Belmont tunnel in comparison!

Yours very truly,

A. N. Müller.

287 Fourth Ave., New York, N. Y., Dec. 15, 1906.

The Failure of the Bixby Hotel: Strength of Reinforced Concrete Columns.

Sir: Regarding the failure of the Bixby Hotel, Long Beach, Cal., it would appear from the facts given in your issue of Nov. 29, and from the following calculations, that the columns were improperly figured, while the floors seem to have been strong enough. I na building of this kind there would seem to be no reason why the failure of one floor panel should injure in any way the neighboring columns, if the latter have any reasonable factor of safety. The following figures speak for themselves. The panel area is 342 sq. ft.

	Total live and dead load, per sq. ft., lbs.	Panel load, lbs.
Roof	70	23,900
5th floor	100	34,200
4th floor	100	34,200
3rd floor	100	34,200
2nd floor	100	34,200
1st floor	200	68,400

	Load—Total, lbs.	Load—Per sq. in., lbs.
5th story cols. 8 × 8-in.	23,900	375
4th story cols. 8 × 8-in.	58,100	800
3rd story cols. 10 × 10-in.	92,300	923
2nd story cols. 12 × 12-in.	126,000	875
1st story cols. 24-in.	160,700	350
B. cols. 21 × 21-in.	229,000	357

The reinforcement, which appears to have consisted of but four ½-in. round rods, was only a sham, and with unit stresses approximately as great as here shown, a little extra stress due to wind pressure would have been sufficient to break the columns.

Yours truly, George Rae.

234 Tenth St., Portland, Ore., Dec. 7, 1906.

Sir: In the issue of Nov. 29 of Engineering News, you write about the collapse of the Bixby Hotel and state that nobody is able to explain why this structure failed. The fact that the plans were changed and that heavy loads came on the columns probably gives the solution of the failure of the building.

I presume that the architect who designed the columns tried to strengthen them by increasing the percentage of steel which they contained, so that the percentage of reinforcing steel in the section exceeded 2%. The tests of columns made by the well-known Prof. C. Bach at the Polytechnikum at Stuttgart, Germany, in charge of the "Eissenbetonkommission der Jubilaeumsstiftung der deutschen Industrie" and published in the pamphlet "C. Bach, Druckversuche mit Eisenbetonkörpern, 1905," show that the reinforcing of columns above 2% has not any value, because a column fails by exceeding the compressive strength of a cube of concrete. It is only possible by reinforcing to develop in a column the compressive strength of a cube of concrete or a small fraction more than that. Of course, the ties are of the greatest importance. The tests of columns 10 × 10 ins., 3½ ft. high, mixture 1:4, are given in abstract in the excellent book on reinforced concrete by Prof. Mörsch:

Percentage of steel.	Spacing of ties. ins.	Breaking strength. lbs. per sq. in.
...	..	2,014
1.14	10	2,400
1.14	5	2,529
1.14	2½	2,929
2.04	10	2,429
4.09	10	2,714
Breaking strength of a cube of concrete of the same mixture without reinforcement.....		2,500

Ties $^9/_{32}$-in. diameter. Concrete 3 mos. old at time of test.

This table shows that the reinforcing of columns is limited and that the formula $P = F_c S_c + n F_s S_c$ (where P is the safe load, F_c and F_s the areas of concrete and steel, $n = \frac{E_s}{E_c} = 15$ and S_c the allowable stress of concrete) can only be applied when the cross-section of steel is less than 1½% to 2% of the section of concrete.

Yours truly,

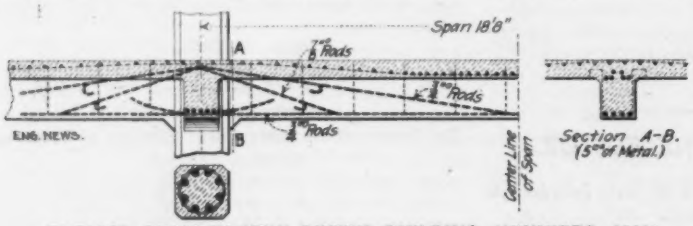
Paul Mast.

27 West Market St., York, Pa., Dec. 1, 1906.

The Bixby Hotel Failure: Provision to Resist Shear in Reinforced Concrete Beams.

Sir: The failure of the Bixby Hotel at Long Beach, Cal., described in your issue of Nov. 29, places additional emphasis on a persistently ignored element of design, to wit.: shear in concrete beams. A discussion of the features of design of this recent collapse, costly in lives and profit, may be of some benefit to the concrete industry.

Referring to Figs. 2, 4 and 6 of your article, it will be seen that many of the beams have sheared close to the column, and that this point would seem to indicate a point of weakness in the design. Referring to Fig. C, it



TYPICAL BEAM IN NEW AIKENS BUILDING, WINNIPEG, MAN.
J. Woodman, Architect; C. A. P. Turner, Engineer and Contractor.

will be seen that the beam is designed practically as a simple beam, with a small Kahn tie bar over the supporting column, marked "Top bar ¾-in. by 2 ins. by 7 ft."; that the bottom beam reinforcement is two Kahn bars 1 in. by 3 ins. by 17 ft. 8 ins. and a short Kahn bar ¾-in. by 2 ins. by 13 ft.; in other words, the section provided at the bottom of the beam is about 2¼ sq. ins. in the center of the span and about ¾-sq. in. over the column, while, if designed as a continuous beam, the major section should be over the column. Hence, it would seem that there is a very unscientific distribution of material, and second, that the long bottom bar in the beam stops just inside the skin of the column, so that the shear, which is a maximum at the bearing of the beam, must be taken by the concrete alone. A glance at the design of the connection of the roof beams to the 8 by 8-in. columns shows positively no provision for shear, for experience in the field has taught the writer that in not one case out of ten would the long bottom bar be placed with exactly 2 ins. bearing on the column at each end, the more probable condition being 2 ins. off one end and 6 ins. on the other, so that, at the time of removing the forms, there is nothing more than the shear on 8 × 18 ins. of green concrete, possessing a very low shearing value at that age, to hold up its proportional part of an 18 by 18-ft. panel. It must be observed that concrete in its early stages, in hardening, develops compressive strength much more rapidly in proportion than shearing strength. It would be as reasonable to expect to stick a beam on the face of a brick wall. The small bar over the column can scarcely add much to strength in shear, being placed in the top of the beam and dependent on the adhesion of the green concrete to a few fins, this adhesion being further lessened by the fact that the top of the beam is in tension over the support as a continuous beam. These features, it seems, would account for the break in the beam, as the entire shear must be carried by the concrete with practically no assistance from the steel.

The claim made for the patent Kahn bar used in the Bixby Hotel building is that it is especially designed to carry shear; its real weakness would seem to be indicated by the failure of all the beams shown in your descriptive article by shear at the end; in other words, the fins of these bars are distributed in the wrong place to carry shear effectively, and it is doubtful if they have sufficient length to be of any considerable service in providing for shear at the end of the beam where the shear is a maximum.

In studying the various methods employed in the design of reinforced concrete and observing the construction in the field, the writer has noted a too frequent carelessness in regard to shear, the Kahn bar not being the only offender. The unit beam of the Valliere type, as it is often placed in construction and as illustrated on p. 127 of Sweet's "Indexed Catalogue of Building Construction," is open to similar criticism. The Cummings system is somewhat of an improvement in this respect, though it leaves something to be desired from the point of bond and shear, the design, like the Kahn, depending too largely on the action of the simple beam rather than on a more logical type of design for continuous reinforcement. A somewhat minor system, the Locher system, described on p. 74 of Marsh's "Reinforced Concrete," seems to cap the climax, with no provision at all for shear. Shear in the Hennebique system is better provided for than in those heretofore mentioned, but the bar projecting straight along the top of the beam is in no position to take shear and its extremities are not needed in full for tension.

It seems to the writer that the most rational solution of the shear problem has been realized in Mr. C. A. P. Turner's system of construction, as employed in the Aikens Building at Winnipeg and many others (see the drawing herewith). It has about the same section in the bottom of the beam at the center as in the Bixby Hotel and about five times the section over the support, distributed in such a manner that the main section of the rods can take shear on each side of the column, the rods being continuous into the next beam, and bending sharply downward toward the point of contraflexure, thus enabling them to take shear and provide for the bending moment, which reduces to zero at that point. This bend, in addition to providing for shear, gives a very positive anchorage in the new concrete. The writer has seen the centering for the Turner system frequently taken down at as early a period as eight days, with no injury to the construction.

Referring now to the columns, it would seem that the vertical column reinforcement in the Bixby Hotel building is almost insignificant, and while the columns may have been made good for vertical loads, if sufficient hooping has been used, your article gives no information whatever on this score. Even with the hooping, in the case of a beam failure, it would seem that there is insufficient metal to provide for any bending stress in the column which may also be caused by possible concentrated loads or wind pressure. It would be interesting to the writer to know upon what basis the architect or designer figured the columns in the Bixby Hotel and also the detail of the reinforcement.

It is only by a thorough discussion of such failures that others may be prevented from coming to grief in like manner.

Yours very truly,

D. B. Fegles,
Assistant Engineer with C. A. P. Turner.
816 Phoenix Bldg., Minneapolis, Minn., Dec. 6, 1906.

The Relative Merits of Rim-Bearing and Wedge-Bearing Draw Spans.

Sir: The accident at the drawbridge at Atlantic City has revived interest in drawbridges, at least it should revive such interest. This is not a discussion of the direct cause of that calamity. The evidence shows conclusively that failure of the bridge tender to hammer down the loose rail in place, coupled with a signal system that was liable to lie, were responsible for the terrible loss of life.

The writer wishes to present a short discussion of the relative merits of rim-bearing and wedge-bearing draw-spans. A center-bearing draw-span with wedges is cheaper than a rim-bearing draw-span. It is true that wedge-bearing spans seem to have the preference, when practice is taken as a criterion, and an engineer who flies in the face of precedent is liable to be severely criticised. The writer had the distinction of having applied to him the most profane appellation that it has ever been his lot to be called, by a resident engineer in a western city, because of his opposition to a bridge of this sort. He has been otherwise criticised for his failure to fall in line with current practice.

A great deal of ingenuity is expended in devising means to drive the six or more wedges upon which a wedge-bearing draw-span with a center pivot is to rest when in use. If one-half of this skill were exerted to improve the good old reliable rim-bearing type of span, a bridge that is immensely safer would result.

We have all been schooled in the awfulness of using continuous beams because of the unknown and mysterious results that might ensue if the supports did not fit the unstressed contour of the beam. We hear scarcely anything about the dire consequences of resting a girder or truss on three and one-half supports, three of which are simultaneously pushed under it. The half support is the pivot which carries an entirely indeterminate part of the load on the center pier. There is no means of determining, even approximately, the amount of load borne by the middle wedges and the pivot. Strain sheets show a very nice distribution, allowing the wedges to take the live load on the truss and the pivot girders to carry only their own live panel load in addition to the dead weight of the bridge. This is a sort of fiat, rather than a rational assumption. A short, rigid girder with practically no deflection cannot be made to distribute its load in any such prescribed parcels.

A wedge-bearing pivoted span is dangerous when the wedges are not driven, as it rests on a pivot calculated to support only the dead load and a small part of the live load in the middle panel. It therefore depends solely on the operator. An old-fashioned rim-bearing span is ready for traffic the instant the tracks are in line, and any one on the street can see whether or not it is so.

If the wedges of a wedge-bearing span are not driven home, or if they are out of adjustment, so that some come to a bearing while others do not, a condition arises that no simple assumption of separate span stresses in each arm will meet. This latter is a make-shift used by designers of these bridges to cover a fundamental weakness. It might as well be included in the factor of ignorance."

In the matter of tracks there is a great advantage in the rim-bearing spans over wedge-bearing spans. A drawbridge having a separate piece of rail, which must be lifted and lowered, adds complication that increases the danger. This was exemplified at Atlantic City. If the end floorbeam finds support on rollers at a fixed elevation, the track can be rigidly attached to both bridge and abutment, or a short extension of a few inches of rail could slide onto a rigid bracket on the abutments, thus giving a continuous track as soon as the bridge is latched.

Much is said about the great uplift from live load that is exerted on the far side of the drum when one arm of a rim-bearing span is loaded, and the inability to provide anchorage. The dead load of one-half of the bridge is there to act as anchorage, and calculations based on the extension of members show that the actual uplift is relatively small.

The difficulty of making a track for the drum rollers that is true and level is a drawback in the execution of plans of rim-bearing bridges. This could be greatly minimized if the track segments, instead of being seated on the masonry and bolted to the same, were detailed to bolt to a curved girder, planed on top to a true surface. This girder need not be made of the rigidity of the drum, nor anything approaching it, but could be made of sections that will be stiff enough to retain the shape in handling. It could be placed on the pier when finishing the same, and can be readily made truly level. Blocked up in this position it could then be built into the pier with concrete or mortar, and grout where necessary. This would be a secure anchor for the track segments and the rack and a tie for the pier. The pier itself would take the load of the rollers.

Another bugbear, namely, the hammering of the unloaded end of the span, could be readily overcome, if desirable, by building an eyebar into the abutment and driving a pin through it and two bars in the draw, when the bridge comes into its place. This would be a safeguard the omission to operate which would have no serious consequences.

Yours very truly,

Edward Godfrey.
Monongahela Bank Bldg., Pittsburg, Pa., Dec. 8, 1906.

Notes and Queries.

In our reprint of Major Pringle's report on the Salisbury (England) railway accident, in our issue of Dec. 6, the engine of the wrecked train was twice mentioned as being of the 2-4-0 class. This should have been 4-4-0, the engine being of the eight-wheel type, with four driving wheels and a four-wheel leading truck.

The relation of track to speed of trains was discussed at some length in our issue of Sept. 13, and particulars were given of the conditions on a number of lines. We have since received the following information in regard to the Lake Shore & Michigan Southern Ry. The opinion is held that for slow traffic on main tracks the minimum weight of rail should be 65 lbs. per yd., with 3,500 ties per mile and 12 ins. of ballast under the ties. For high-speed traffic on main tracks, the minimum weight of rail should be 80 lbs. per yd., with 3,300 ties per mile and the same depth of ballast. The standard sizes of ties for the above conditions are 6 × 8 ins. and 8 ft. long for the slow-speed, and 7 × 9 ins. and 8½ ft. long for the high-speed track. The minimum weight of rail in main track on the main lines is 80 lbs. per yd., but this is being renewed with 100-lb. rails as fast as possible. The heaviest locomotives operating over tracks of the slow-speed tracks with 65-lb. rails are as follows: Freight engines of the consolidation (2-8-0) type weighing 230,000 lbs., with 203,000 lbs. on the eight driving wheels; passenger engines of the prairie type (2-6-2), weighing 233,000 lbs., with 165,200 lbs. on six driving wheels. The maximum speeds are about 40 miles per hour on the 65-lb. rails and 100 miles per hour on the 80-lb. rails. The traffic on this line is approximately 88% freight and 12% passenger traffic.

A PRESERVATIVE PROCESS FOR WOOD intended for the interior finish of buildings, railway cars, etc., and for furniture, etc., has been invented by a Mr. Horak, and is in use at his factory at Klosterneuburg, near Vienna, Austria. The process is applied to green timber, the preservative fluid being forced in under hydraulic pressure. The same fluid is also used to give the wood any desired color, and when the wood is dried it can be sawed and turned for manufacture. It is claimed that by this treatment all interior painting may be avoided, the colored wood being simply polished or varnished. It is further claimed that the treatment makes the timber free from attack by insects, and that by a slight additional treatment the wood can be rendered fireproof. No details of the process or the preservative have been made public.

PRESIDENT ROOSEVELT'S SPECIAL MESSAGE ON THE PANAMA CANAL.*

To the Senate and House of Representatives:

In the month of November I visited the Isthmus of Panama, going over the Canal Zone with considerable care; and also visited the cities of Panama and Colon, which are not in the Zone or under the United States law, but as to which the United States Government, through its agents, exercises control for certain sanitary purposes.

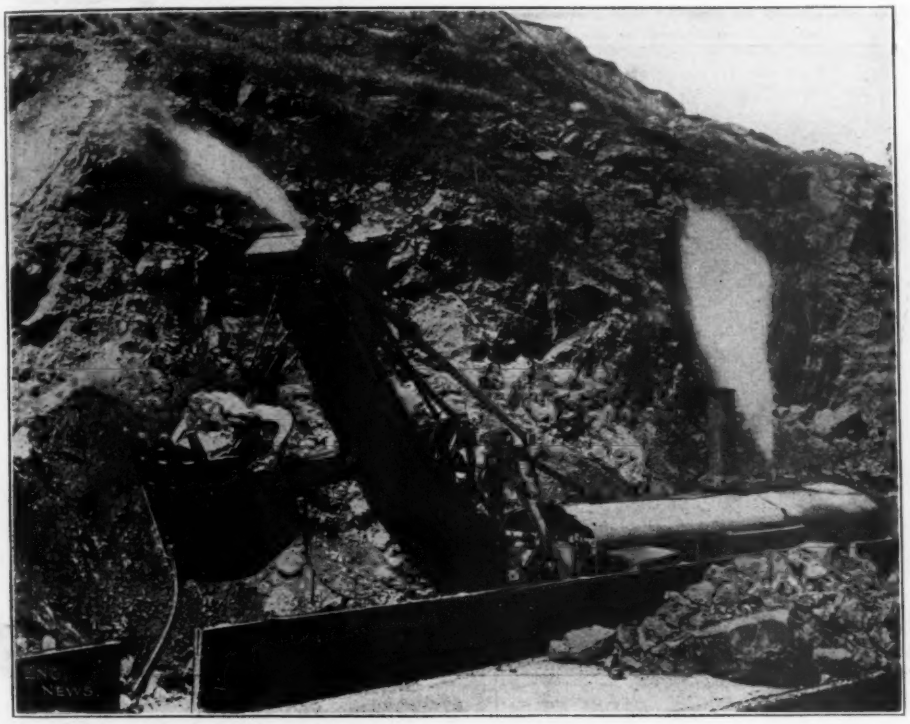


FIG. 1. STEAM SHOVEL AT WORK IN BAS OBISPO CUT.

I was three days ashore—not a sufficient length of time to allow of an exhaustive investigation of the minutiæ of the work of any single department, still less to pass judgment on the engineering problems, but enough to enable me to get a clear idea of the salient features of the great work and of the progress that has been made as regards the sanitation of the Zone, Colon, and Panama, the caring for and housing of the employees, and the actual digging of the canal. The Zone is a narrow strip of land, and it can be inspected much as one can inspect 50 or 60 miles of a great railroad, at the point where it runs through mountains or overcomes other natural obstacles.

I chose the month of November for my visit partly because it is the rainiest month of the year, the month in which the work goes forward at the greatest disadvantage, and one of the two months which the medical department of the French Canal Company found most unhealthy.

Immediately after anchoring on the afternoon of Wednesday there was a violent storm of wind and rain. From that time we did not again see the sun until Saturday morning, the rain continuing almost steadily, but varying from a fine drizzle to a torrential downpour. During that time in fifteen minutes at Cristobal 1.05 ins. of rain fell; from 1 to 3 a. m., Nov. 16, 3.2 ins. fell; for the twenty-four hours ending noon, Nov. 16, 4.68 ins. fell, and for the six days ending noon, Nov. 16, 10.24 ins. fell. The Chagres rose in flood to a greater height than it had attained during the last fifteen years, tearing out the track in one place. It would have been impossible to see the work going on under more unfavorable weather conditions.

On Thursday morning we landed at about half past seven and went slowly over the line of the Panama Railway, ending with an expedition in a tug at the Pacific entrance of the canal out to the islands where the dredging for the canal will cease. We took our dinner at one of the eating houses furnished by the Commission for the use of the Government employees—no warning of our coming being given. I inspected the Ancon Hospital, going through various wards both for white patients and for colored patients. I inspected portions of the constabulary (Zone police), examining the men individually.

On Friday morning we left the hotel at 7 o'clock and spent the entire day going through the Culebra cut—the spot in which most work will have to be done in any event. We watched the different steam shovels working; we saw the drilling and blasting; we saw many of the dirt trains (of the two different types used), both carrying the earth away from the steam shovels and depositing it on the dumps—some of the dumps being run out in the jungle merely to get rid of the earth, while in other cases they are being used for double tracking the railway, and in preparing to build the great dams. I visited many of the different villages, inspecting thoroughly many different buildings.

On Saturday morning we started at 8 o'clock from the hotel. We went through the Culebra cut, stopping off to see the marines, and also to investigate certain towns; one, of white employees, as to which in certain respects complaint had been made to me; and another town where I wanted to see certain houses of the colored employees. We went over the site of the proposed Gatun dam, having on the first day inspected the sites of the proposed La Boca and Sosa dams. We went out on a little toy railway to the reservoir, which had been built to supply the people of Colon with water for their houses. There we took lunch at the engineers' mess. We then went through the stores and shops of Cristobal, inspecting carefully the houses of both the white and colored employees, married and unmarried, together with the other buildings. We then went to Colon and saw the fire department at work; in four minutes from the signal the engines had come down to Front St., and twenty-one 2½-in. hose pipes were raising streams of water about 75 ft. high. We rode about Colon, through the various streets, paved, unpaved, and in process of paving, looking at the ditches, sewers, curbing, and the lights.

At the outset I wish to pay a tribute to the amount of work done by the French Canal Company under very difficult circumstances. Many of the buildings they put up were excellent and are still in use, though, naturally, the houses are now getting out of repair and are being used as dwellings only until other houses can be built, and much of the work they did in the Culebra cut, and some of the work they did in digging has been of direct and real benefit. This country has never made a better investment than the $40,000,000 which it paid to the French Company for work and betterments, including especially the Panama Railroad.

PRELIMINARY WORK BEING DONE.

The wisdom of the canal management has been shown in nothing more clearly than in the way in which the foundations of the work have been laid. To have yielded to the natural impatience of ill-informed outsiders and begun all kinds of experiments in work prior to a thorough sanitation of the Isthmus, and to a fairly satisfactory working out of the problem of getting and keeping a sufficient labor supply, would have been disastrous. The various preliminary measures had to be taken first; and these could not be taken so as to allow us to begin the real work of construction prior to Jan. 1 of the present year. It then became necessary to have the type of the canal decided, and the only delay has been the necessary delay until the 29th day of June, the date when the Congress definitely and wisely settled that we should have an 85-ft. level canal. Immediately after that the work began in hard earnest and has been continued with increasing vigor ever since; and it will continue so to progress in the future. When the contracts are let the conditions will be such as to insure a constantly increasing amount of performance.

The first great problem to be solved, upon the solution of which the success of the rest of the work depended, was the problem of sanitation. This was from the outset under the direction of Dr. W. C. Gorgas, who is to be made a full member of the Commission if the law as to the composition of the Commission remains unchanged. It must be remembered that his work was not mere sanitation as the term is understood in our ordinary municipal work. Throughout the Zone and in the two cities of Panama and Colon, in addition to the sanitation work proper, he has had to do all the work that the Marine-Hospital Service does as regards the Nation, that the health department officers do in the various states and cities, and that Colonel Waring did in New York when he cleaned its streets. The results have been astounding. The Isthmus had been a by-word for deadly unhealthfulness. Now, after two years of our

FIG. 2. STEAM DRILLS AT WORK IN BAS OBISPO CUT.

*Condensed from the original, which was transmitted to Congress on Dec. 17.

occupation the conditions as regards sickness and the death rate compare favorably with reasonably healthy localities in the United States.

Especial care has been devoted to minimizing the risk due to the presence of those species of mosquitoes which have been found to propagate malarial and yellow fevers. In all the settlements, the little temporary towns or cities composed of the white and black employees, which grow up here and there in the tropic jungle as the needs of the work dictate, the utmost care is exercised to keep the conditions healthy. Everywhere are to be seen the drainage ditches which in removing the water have removed the breeding places of the mosquitoes, while the whole jungle is cut away for a considerable space around the habitations, thus destroying the places in which the mosquitoes take shelter. These drainage ditches and clearings are in evidence in every settlement, and, together with the invariable presence of mosquito screens around the piazzas, and of mosquito doors to the houses, not to speak of the careful fumigation that has gone on in all infected houses, doubtless explain the extraordinary absence of mosquitoes. As a matter of fact, but a single mosquito, and this not of the dangerous species, was seen by any member of our party during my three days on the Isthmus. Equal care is taken by the inspectors of the health department to secure cleanliness in the houses and proper hygienic conditions of every kind.

HEALTH SHOWING REMARKABLY GOOD.

Just at present the health showing on the Isthmus is remarkably good—so much better than in most sections of the United States that I do not believe that it can possibly continue at quite its present average. There has been for the last six months a well-nigh steady decline in the death rate for the population of the Zone, this being largely due to the decrease in deaths from pneumonia, which has been the most fatal disease on the Isthmus. In October there were 99 deaths of every kind among the employees of the Isthmus. There were then on the rolls 5,500 whites, seven-eighths of them being Americans. Of these whites but two died of disease, and as it happened neither man was an American. Of the 6,000 white Americans, including some 1,200 women and children, not a single death has occurred in the past three months, whereas in an average city in the United States the number of deaths for a similar number of people in that time would have been about thirty from disease. This very remarkable showing can not of course permanently obtain, but it certainly goes to prove that if good care is taken the Isthmus is not a particularly unhealthy place. In October, of the 19,000 negroes on the roll 86 died from disease; pneumonia being the most destructive disease, and malarial fever coming second. The difficulty of exercising a thorough supervision over the colored laborers is of course greater than is the case among the whites, and they are also less competent to take care of themselves, which accounts for the fact that their death rate is so much higher than that of the whites, in spite of the fact that they have been used to similar climatic conditions. Even among the colored employees it will be seen that the death rate is not high.

In Panama and Colon the death rate has also been greatly reduced, this being directly due to the vigorous work of the special brigade of employees who have been inspecting houses where the stegomyia mosquito is to be found, and destroying its larvae and breeding places, and doing similar work in exterminating the malarial mosquito—in short in performing all kinds of hygenic labor. A little over a year ago all kinds of mosquitoes, including the two fatal species, were numerous about the Culebra cut. In this cut during last October every room of every house was carefully examined, and only two mosquitoes, neither of them of the two fatal species, were found. Unfaltering energy in inspection and in disinfecting and in the work of draining and of clearing brush are responsible for the change.

UNJUST CRITICISM.

Care and forethought have been exercised by the Commission, and nothing has reflected more credit upon them than their refusal either to go ahead too fast or to be deterred by the fear of criticism from not going ahead fast enough. It is curious to note the fact that many of the most severe critics of the Commission criticize them for precisely opposite reasons, some complaining bitterly that the work is not in a more advanced condition, while the others complain that it has been rushed with such haste that there has been insufficient preparation for the hygiene and comfort of the employees. As a matter of fact neither criticism is just. It would have been impossible to go quicker than the Commission has gone, for such quickness would have meant insufficient preparation. On the other hand, to refuse to do anything until every possible future contingency has been met would have caused wholly unwarranted delay. The right course to follow was exactly the course which has been followed. Every reasonable preparation was made in advance, the hygienic conditions in especial being made as nearly perfect as possible; while on the other hand there has been no timid refusal to push forward the work because of inability to anticipate every possible emergency, for, of course, many defects can only be shown by the working of the system in actual practice.

FIG. 3. STONE CRUSHER AT WORK AT BAS OBISPO.

FIG. 4. THE CANAL COMMISSION'S MOUNT HOPE STORE, THE LARGEST ON THE ISTHMUS, THROUGH WHICH ALL SUPPLIES FOR THE ISTHMUS ARE DISTRIBUTED.

CARE OF EMPLOYEES.

At present there are some 6,000 white employ[illegible]nd some 19,000 colored employees on the Isthmus.

Nealy 5,000 of the white employees had come f[illegible]he United States. They represent on the average [illegible]gh class. Doubtless to Congress the wages paid th[illegible]ill seem high, but as a matter of fact the only [illegible]ral complaint which I found had any real basis am[illegible]he complaints made to me upon the Isthmus was th[illegible]w- ing to the peculiar surroundings, the cost of livi[illegible]nd the distance from home, the wages were really not a[illegible]gh as they should be. In fact, almost every man I spoke to felt that he ought to be receiving more money—a view, however, which the average man who stays at home in the United States probably likewise holds as regards himself. I append figures of the wages paid, so that the Congress can judge the matter for itself. Later I shall confer on the subject with certain representative labor men here in the United States, as well as going over with Mr. Stevens, the comparative wages paid on the Zone and at home; and I may then communicate my finding to the canal committee of the two Houses.

The bachelors among the employees live, sometimes in small separate houses, sometimes in large houses; quarters being furnished free to all the men, married and unmarried. The wives of the steam-shovel men, engineers, machinists, and carpenters into whose houses I went, all with one accord expressed their pleasure in their home life and surroundings. Indeed, I do not think they could have done otherwise. The houses themselves were excellent—bathroom, sitting room, piazza, and bedrooms being all that could be desired.

The housewives purchased their supplies directly, or through their husbands, from the commissary stores of the Commission. The married men ate at home. The unmarried men sometimes ate at private boarding houses, or private messes, but more often, judging by the answers of those whom I questioned, at the government canteens or hotel where the meal costs 30 cents to each employee. This 30-cent meal struck me as being as good a meal as we get in the United States at the ordinary hotel in which a 50-cent meal is provided. Three-fourths of the men whom I questioned stated that the meals furnished at these government hotels were good, the remaining one-fourth that they were not good. I myself took dinner at the La Boca government hotel, no warning whatever having been given of my coming. My meal was excellent, and two newspaper correspondents who had been on the Isthmus several days informed me that it was precisely like the meals they had been getting elsewhere at other Government hotels.

I came to the conclusion that, speaking generally, there was no warrant for complaint about the food. Doubtless it grows monotonous after a while. Any man accustomed to handling large masses of men knows that some of them, even though otherwise very good men, are sure to grumble about something, and usually about their food. Schoolboys, college boys and boarders in boarding houses make similar complaints; so do soldiers and sailors.

CHINESE AND OTHER LABOR.

Of the nineteen or twenty thousand day laborers employed on the canal, a few hundred are Spaniards. They do excellent work. Their foreman told me that they did twice as well as the West Indian laborers. The[illegible] keep

healthy and no difficulty is experienced with them in any way. Some Italian laborers are also employed in connection with the drilling. A steady effort is being made to secure Italians, and especially to procure more Spaniards, because of the very satisfactory results that have come from their employment; and their numbers will be increased as far as possible. It has not proved possible, however, to get them in anything like the numbers needed for the work, and from present appearances we shall in the main have to rely, for the ordinary unskilled work, partly upon colored laborers from the West Indies, partly upon Chinese labor. It certainly ought to be unnecessary to point out that the American workingman in the United States has no concern whatever in the question as to whether the rough work on the Isthmus, which is performed by aliens in any event, is done by aliens from one country with a black skin or by aliens from another country with yellow skin. Our business is to dig the canal as efficiently and as quickly as possible; provided always that nothing is done that is inhumane to any laborers, and nothing that interferes with the wages of or lowers the standard of living of our own workmen. Having in view this principle, I have arranged to try several thousand Chinese laborers. This is desirable both because we must try to find out what laborers are most efficient, and, furthermore, because we should not leave ourselves at the mercy of any one type of foreign labor.

The West Indian laborers are fairly, but only fairly satisfactory. Some of the men do very well indeed; the better class, who are to be found as foremen, as skilled mechanics, as policemen, are good men; and many of the ordinary day laborers are also good. But thousands of those who are brought over under contract (at our expense) go off into the jungle to live, or loaf around Colon, or work so badly after the first three or four days as to cause a serious diminution of the amount of labor performed on Friday and Saturday of each week. Not only were the quarters in which these negro laborers were living much superior to those in which I am informed they live at home, but they were much superior to the huts to be seen in the jungles of Panama itself, beside the railroad tracks, in which the lower class of native Panamans live, as well as the negro workmen when they leave the employ of the canal and go into the jungles.

This gathering, distributing, and caring for the great force of laborers is one of the giant features of the work. That friction will from time to time occur in connection therewith is inevitable. The astonishing thing is that the work has been performed so well and that the machinery runs so smoothly. From my own experience I am able to say that more care had been exercised in housing, feeding, and generally paying heed to the needs of the skilled mechanics and ordinary laborers in the work on this canal than is the case in the construction of new railroads or in any other similar private or public work in the United States proper; and it is the testimony of all people competent to speak that on no other similar work anywhere in the Tropics—indeed, as far as I know, anywhere else—has there been such forethought and such success achieved in providing for the needs of the men who do the work.

FIG. 5. VIEW IN CULEBRA CUT.

(The level at which the two men are standing is that reached by the French. The level at which the motor car stands is the present American level, 65 ft. below.)

FIG. 6. VIEW OF SECTION OF RAILWAY YARD AT LAS CASCADAS.

(This is the clearing house, on the Atlantic side, for the trains of spoil from the Culebra Cut.)

WORK OF CONSTRUCTION.

The work is now going on with a vigor and efficiency pleasant to witness. The three big problems of the canal are the La Boca dams, the Gatun dam, and the Culebra cut. The Culebra cut must be made, anyhow; but of course changes as to dams, or at least as to the locks adjacent to the dams, may still occur. The La Boca dams offer no particular problem, the bottom material being so good that there is a practical certainty, not merely as to what can be achieved, but as to the time of achievement. The Gatun dam offers the most serious problem which we have to solve; and yet the ablest men on the Isthmus believe that this problem is certain of solution along the lines proposed; although, of course, it necessitates great toil, energy, and intelligence, and although equally, of course, there will be some little risk in connection with the work. If the huge earth dam now contemplated is thrown across from one foothill to the other we will have what is practically a low, broad, mountain ridge behind which will rise the inland lake. This artificial mountain will probably show less seepage, that is, will have greater restraining capacity than the average natural mountain range. The exact locality of the locks at this dam—as at the other dams—is now being determined. In April next Secretary Taft, with three of the ablest engineers of the country—Messrs. Noble, Stearns, and Ripley—will visit the Isthmus, and the three engineers will make the final and conclusive examinations as to the exact site for each lock. Meanwhile the work is going ahead without a break.

The Culebra cut does not offer such great risks; that is, the damage liable to occur from occasional land slips will not represent what may be called major disasters. The work will merely call for intelligence, perseverance, and executive capacity. It is, however, the work upon which most labor will have to be spent. The dams will be composed of the earth taken out of the cut and very possibly the building of the locks and dams will take even longer than the cutting in Culebra itself.

The main work is now being done in the Culebra cut. It was striking and impressive to see the huge steam shovels in full play, the dumping trains carrying away the rock and earth they dislodged. There were some 25 steam shovels at work during the time I was on the Isthmus, and their tremendous power and efficiency were most impressive.

As soon as the type of canal was decided this work began in good earnest. The rainy season will shortly be over and then there will be an immense increase in the amount taken out; but even during the last three months, in the rainy season, steady progress is shown by the figures. In August 242,000 cubic yards; in September, 291,000 cubic yards, and in October, 325,000 cubic yards. In October new records were established for the output of individual shovels as well as for the tonnage haul of individual locomotives. I hope to see the growth of a healthy spirit of emulation between the different shovel and locomotive crews. On the top notch of the Culebra cut the prism is now as wide as it will be; all told, the canal bed at this point has now been sunk about 200 ft. below what it originally was. It will have to be sunk about 130 ft. farther. Throughout the cut the drilling, blasting, shoveling, and hauling are going on with constantly increasing energy.

FIG. 7. MESS HALL AT CULEBRA, IN WHICH MEN ARE PERMITTED TO EAT WITHOUT THEIR COATS.

FIG. 8. DINING-ROOM IN MARRIED MEN'S QUARTERS AT CULEBRA.

The most advanced methods, not only in construction, but in railroad management, have been applied in the Zone, with corresponding economies in time and cost.

PLAN TO BUILD BY CONTRACT.

After most careful consideration we have decided to let out most of the work by contract, if we can come to satisfactory terms with the contractors. The whole work is of a kind suited to the peculiar genius of our people; and our people have developed the type of contractor best fitted to grapple with it. It is of course much better to do the work in large part by contract than to do it all by the Government, provided it is possible on the one hand to secure to the contractor a sufficient remuneration to make it worth while for responsible contractors of the best kind to undertake the work; and provided, on the other hand, it can be done on terms which will not give an excessive profit to the contractor at the expense of the Government. After much consideration the plan already promulgated by the Secretary of War was adopted. This plan in its essential features was drafted, after careful and thorough study and consideration, by the Chief Engineer, Mr. Stevens, who, while in the employment of Mr. Hill, the president of the Great Northern Railroad, had personal experience of this very type of contract. Mr. Stevens then submitted the plan to the Chairman of the Commission, Mr. Shonts, who went carefully over it with Mr. Rogers, the legal adviser of the Commission, to see that all legal difficulties were met. He then submitted copies of the plan to both Secretary Taft and myself. Secretary Taft submitted it to some of the best counsel at the New York bar, and afterwards I went over it very carefully with Mr. Taft and Mr. Shonts, and we laid the plan in its general features before Mr. Root. My conclusion is that it combines the maximum of advantage with the minimum of disadvantage. Under it a premium will be put upon the speedy and economical construction of the canal, and a penalty imposed on delay and waste. The plan as promulgated is tentative; doubtless it will have to be changed in some respects before we can come to a satisfactory agreement with responsible contractors—perhaps even after the bids have been received; and of course it is possible that we cannot come to an agreement, in which case the Government will do the work itself. Meanwhile the work on the Isthmus is progressing steadily and without any let-up.

A SINGLE COMMISSIONER DESIRED.

A seven-headed commission is of course a clumsy executive instrument. We should have but one commissioner, with such heads of departments and other officers under him as we may find necessary. We should be expressly permitted to employ the best engineers in the country as consulting engineers.

When the Culebra cut has been made and the dams built (if they are built as at present proposed) there will then be at both Pacific and Atlantic ends of the canal, two great fresh-water lakes, connected by a broad channel running at the bottom of a ravine, across the backbone of the Wester Hemisphere. Those best informed believe that the work will be completed in about eight years; but it is never safe to prophesy about such a work as this, especially in the Tropics.

CONFIDENT OF ULTIMATE SUCCESS.

Under Mr. Shonts and Mr. Stevens and Doctor Gorgas this work has started with every omen of good fortune. They and their worthy associates, from the highest to the lowest, are entitled to the same credit that we would give to the picked men of a victorious army; for this conquest of peace will, in its great and far-reaching effect, stand as among the very greatest conquests, whether of peace or war, which have ever been won by any of the peoples of mankind. A badge is to be given to every American citizen who for a specified time has taken part in this work; for participation in it will hereafter be held to reflect honor upon the man participating. Our fellow-countrymen on the Isthmus are working for our interests and for the national renown in the same spirit and with the same efficiency that the men of the Army and Navy work in time of war. It behooves us in our turn to do all we can to hold up their hands and to aid them in every way to bring their great work to a triumphant conclusion.

Theodore Roosevelt.

The White House, Dec. 17, 1906.

PROFESSIONAL ETHICS FOR ENGINEERS.*

By Rossiter W. Raymond, Sec. Am. Inst. Min. E.†

Most of you, no matter whether electrical engineers, or engineers of any other class, will have to take occupation and find employment and action in one of four capacities. Most of you will sooner or later be authors, not of a big book necessarily, or even of a little book; perhaps only authors of a professional paper to your institute or of a professional report to a client. Secondly, you will be employees; thirdly, you will have to act as agents; and fourthly, you will be called upon as advisers. I shall offer you a very simple talk about the duties of the four employments I have named.

FIG. 9. ROOM IN BACHELOR QUARTERS AT CULEBRA.

1. Authorship.—In my experience of 22 or 23 years continuously as editor of scientific work done by the ablest men of the engineering profession, I have found a serious lack of conscience in authorship, or, rather, ignorance of the ethics of authorship, among the educated young men of this generation.

An author who is telling somebody his thoughts, has made a tacit agreement or contract with his reader. He practically promises, as the party of the first part, to the party of the second part, that he has paid attention to a certain subject, that he has something to say about it, knows what it is he is going to say, and will undertake to say it so that the party of the second part can understand it. That is the agreement between author and reader, and the author has no right to violate any part of it.

Clauses misplaced are simply belated afterthoughts. Confused statement means confused studying, means that you have not thought out what you want to say, do not know what you are going to say, do not know how to say it, and have not tried to find out. You went on, possibly dictating to a stenographer (which is the besetting literary sin of our age), and communicated therefore to your reader, not the product of your thought, but the process. The reader does not care for the process; he wants the result: How many of us, writing in this slipshod way, have dragged our readers through the process, and have failed to give the product?

More than that, you ought not to conceal from your reader, by any device or evasion or circumlocution, the extent of your knowledge. You ought not to pretend to know more than you do. For instance, you know German. Most of you have to; and it is the best language outside of our own for a technical man to know. Now, suppose you get a German book and there is in it a quotation from Plato or Pliny. You like to show culture; and when you write your paper you desire to quote this passage, and repeat it out of the German book, not out of Pliny. Nine times out of ten you will have reason to be sorry, because most people do not quote Plato or Pliny or anybody else correctly, and because you will have made yourself responsible for another man's error. You did not say, "I found this quoted in such and such a book." Now, that is a crime of authorship, to quote a thing you have not yourself seen in the original. If you found it somewhere else, say so in a foot note.

Again, when you put a thing in quotation marks, be sure that it is quoted verbatim. You have no right to put quotation marks to a version or summary of your own.

In my editing of the Transactions of the American Institute of Mining Engineers, a publication of more than one thousand pages octavo every year, I have employed an assistant whose duty it was to look up quotations and references, and see that they were correct; and very often they were not!

2. As employees, your professional ethics from the standpoint either of principle or policy, should be based upon a consideration of your duties rather than upon your rewards or supposed rights. The man that fills, overfills and overflows the position in which he stands, is not only the good man who rejoiceth the heart of his employer, but is going to be the successful one.

Henry R. Worthington, my namesake, and a warm and helpful friend, once said to me, "I can find many young men who are competent to erect engines, but very few whom I can thoroughly trust to do it, in complete devotion to my interest as employer." They are smart enough, but that does not prove that they are loyal enough. Let me assure you who are younger, and call upon those who are older, to bear witness to the truth of what I say: There never was a time since civilization began or industry was set in motion by man, when loyalty was worth more than it is now. These enormous trusts and enterprises, one of the most magnificent of which adorns this city, are going to be ruined unless they can find trustworthy employees.

The time is past when the master could watch all the details. He cannot now do what Peter Cooper used to do in New York—get up and go down to the works and start the furnaces himself, and get things running nicely; then, in the afternoon, go out and collect bills and buy supplies, and carry on the business. He did that for years. But his was then a small business. No head of a large modern business could now imitate him.

The peril of the great enterprises of to-day is that they are breaking down the men at the head. It is not always the president: sometimes he is only a figure-head. But it will be the vice-president or general manager. All these great combinations are, in my judgment, more dangerous to the men at the head and to the stockholders than to anybody else, for that very reason.

It is beyond the capacity of human brains to keep such big things going, unless they have trained and disciplined and retained a body of trustworthy employees. Otherwise they will be ruined. That is the reason why the heads of great enterprises are looking for trustworthy men. Even had you no higher motive than your own welfare, you would be a fool to commence by looking out for yourself and letting your employer go to the devil.

FIG. 10. HOUSES IN THE NEW VILLAGE OF GATUN.

3. Agency.—Under this head policy and law agree: you must loyally represent your principal. Perhaps the most troublesome question brought to me by young engineers is the question of commissions.

Let me tell you one case of my own. I went to buy for my employers a certain type of engine. I examined the various engines, found the kind wanted, and beat the price down by persistent negotiations until I got the very lowest price, and was just going to take the

*Extracts from an address delivered at a meeting of the Schenectady Branch of the American Institute of Electrical Engineers, Oct. 20, 1906.

†Consulting Engineer, 99 John St., New York City.

engine when the seller said, "Of course you are entitled to a commission on this purchase." I said I did not understand it so, that my services were being paid for by my principal, and I would prefer that he made a lower price on the engine. But he said he could not make a lower price on the face of the bill, but was allowed, by a trade agreement with other men in the business, to give a commission to the agent.

Now, had I been younger, I would have preached to that man. I would have said, "Sir, are you aware that you are offering me a moral insult?" But I had learned the custom of the trade, and knew that what he said was true; that he could not reduce the face of the bill, though he could allow me a commission. "Well," I said, "I shall give it to my employer." Of course he smiled a bland smile and said that he had no objections to my giving it to whomsoever I wished. I wasted no time in further professions of honesty, but simply said, "I will take it; but I want it in a check to my order."

I took the check and endorsed it to my employer; and when I reported the purchase of the engine I said, "Here is a commission which they paid me." He looked at it; and he might have said "Good boy! you can have it." But he said nothing of the kind. What is more, it was not right that he should say it. I had been fully paid for my services; the commission belonged to him, and he knew it and I knew it. So I call your attention, not to any heroic virtue in my act, but to the common-sense which I venture to think I exhibited. Namely, I put my name on the back of that check, and it went to the manufacturer, and he knew that I had given it to my employer. And there is the keynote to all such negotiations; it puts you forever in the right. Protestations will do you no good. A pickpocket can beat us in protestations. Let us be honest and get on record; so that nobody can challenge us.

4. Advisers.—You may become advisers either of private clients, of the public, or of courts of justice. Let me say a few words under each of these heads.

As the adviser of a private client, you should not have much difficulty as to professional ethics except that at the beginning you ought not to let your client acquire a false idea of your ability as an adviser.

When you are advising a client, you owe him your best efforts, and should make to him a frank statement as to how well prepared you are to advise him.

In my special profession as a mining engineer, a curious case of casuistry often arises. A person considering the purchase of certain mining property says to me, "Here is the report of the owner. I have agreed to take the property if that report is true; and I want you to verify it." At present I will not take such an order as that from anybody; and if you have the power to choose, I advise you not to take such a one. Yet there is nothing dishonorable in it. It is only difficult and liable to make trouble afterwards. You see that, under those circumstances, you have nothing to do except say whether a certain statement is true or not. The statement may be true, and yet, in your judgment, there may be reasons why your client should not buy the property at the price named.

I prefer that my clients authorize me to advise simply whether they shall buy or not. Then I can return and say, "The statement is correct, but there is another property right by the side of this, for sale at half the money." Under the first form of order, I would not have the right to say that; I would be merely sent to examine into the truth of a certain statement. It is as if you were employed to decide whether a certain horse is sound. It would not be your duty to report, "Yes, the horse is sound; but I know of another sound horse that could be got for less money." On the contrary, it would be your duty to hold your tongue as to everything except the precise question you are employed to investigate. And the acceptance of a professional duty thus limited is perfectly honorable.

On the other hand, it is your right and your interest to be protected against any misuse of such a limited opinion, either by the garbling of your report, by suppressing its qualifying passages, or the use of it, in whole or part, as an endorsement of a scheme of which you had no knowledge, made no investigation, and would not have given a favorable opinion. Make your report in writing. Phrase it so that it cannot be innocently garbled. And if it should be thus misused, protest promptly. Don't come limping in, after a scheme has failed, to protest that you never meant to approve it in all respects. Speak quick, or shut up!

A word or two as to the duty of an expert witness in court. There has been a great deal said about "expert" testimony. Every once in a while some estimable gentleman cries, "Oh! This is all wrong. Just look at the way in which experts come into court and take thousands of dollars in fees for contradictory theories! The true principle is, that the court should appoint the experts, and the experts should have nothing to do with either party, but should simply enlighten the court."

With that proposition I beg leave to differ. I have seen it tried in France, Germany, and possibly in England. Court experts were appointed, and published ponderous volumes, and could not agree. After all, gentlemen, though we are experts ourselves, let us confess that an expert is always more or less of a crank. There is nothing so wholesome for us as to be set up before twelve men who know nothing about our business, and forced to try to teach them. I believe with all my soul that the best way to get the truth in a case of law involving scientific problems is to let experts be put forward by either side and cross-examined before judge and jury. They generally come out in their true size, no matter how inflated they were at the beginning.

We must recognize the fact, however, that, in almost every case of expert evidence, the expert is a partisan. It must be so. Nobody will pay expert fees unless he knows what his expert is going to say. The proper course for you, as an expert, is to take pay in the beginning for the labor of examining the case and telling your client what you think of it. If your opinion is not useful to him, then drop out of the case. You cannot change your opinion honestly. But if you do drop out, you must not use the knowledge you have confidentially gained, either in that trial or in any other proceeding in which your client is involved. Your retainer should be as sacred as that of a lawyer's; and a lawyer would be disbarred for such an action.

When your mind has been made up, the time for indecision is past. It was your business to make yourself thoroughly acquainted with the subject. If you are taken by surprise on the witness stand with a fact you did not know, you have failed in your preparation. But do not attempt to get out by evasion. An expert is sometimes taken by surprise, and in my judgment all he can say is, "I did not know of this fact. I have made up my mind after a careful study of the whole case. It is my honest opinion still. I have not had time to examine the relation of this fact to it. You may use this fact as much as you like. I cannot, at a moment's notice, frame a new opinion." That is the best way out of it. Any extemporaneous fencing with a lawyer brings a man to grief.

And, for heaven's sake, do not be smart! Do not try to get the better of a lawyer in wit or repartee. You are fencing with one hand tied behind you; for you are under oath and he is not. I have seen many a witness beat a lawyer at repartee and then lose the case. On the contrary, I have seen many an honest witness confused and embarrassed, and the jury saw it, and gave him the case.

The best attitude for a witness is an impartial one. He must not seem to be fighting for his client. He should fight for his convictions and his theory; or, rather, he should not fight at all, but assume that the examining lawyer is sincerely anxious to get at the truth of the matter, and give it to him with great courtesy and great affectation of frankness and esteem. The best witness I ever saw spoke with such perfect freedom and pleasure whenever the opposing attorney asked insulting questions that the impertinence reacted in the witness's favor. But if you give provocation, your game is gone. You had better play the game of gentleman. If you do that the court will protect you from any insults. And if the cross-examining attorney says, "Answer me 'Yes' or 'No,'" do not commence to fence and dodge. Say, "As you ask the question I answer 'Yes' (or 'No');" and then request the privilege of explaining your answer. It is your right, and you will get it.

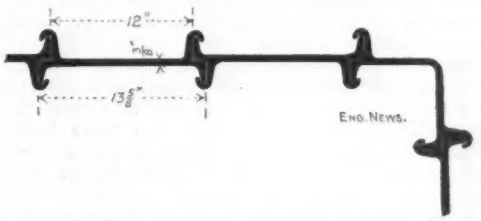
In conclusion, is there not some handy rule which would help us in every case of doubt? The "Golden Rule" and "the Ten Commandments" we all want to keep; but they cannot always be applied in haste or with certainty. Let me suggest something practical, which has religion in it, but not enough to hurt or scare you. "Do not do what you cannot tell," or if there be good reason for not telling, at least "Do not do what you could not tell without shame." If it is a question whether you should take a commission or whether your employer should have it, ask him; and then there is no trouble. If it is a question of practice, doubtful as to ethics, see how it would look in print.

There is another point about this matter of secrecy. When you keep a thing secret, you are not very likely to make a complete record of it. Now, there is nothing more foolish than not to keep your record perfectly clear. It is most humiliating to a man to be, after thirty years or so, unable to explain some particular payment, which he knows was honestly made, simply because the stubs in his check-book do not tell the particulars. Keep your memorandum books up to date and in good order, so that anyone can see them. If you are ordered to do a thing which you do not approve, get the whole thing in writing, and make your record clear. We have been told upon the highest authority that men love darkness better than light when their deeds are evil. If you are not of such, why not walk in the light?

A NEW TYPE OF INTERLOCKING STEEL SHEET PILING.

The rapid extension of the use of steel sheet piling for cofferdams, open caissons and foundation works of various kinds is stimulating the invention of new forms. In one of the latest of these, which has recently been put on the market, each pile is a single rolled piece of a special section, which from the accompanying cut will be seen to be a modified form of I-beam, with the flanges so formed that those of adjacent piles interlock with one another.

This pile was designed and patented some two years ago, but difficulty was found in rolling the hooked flanges, and owing to the great demand for ordinary structural material the mills could spare little time for devising methods of rolling special sections. The Jones & Laughlin Steel Co., of Pittsburg, has now perfected a method of rolling this particular section, and the first lot of piles has recently been manufactured. The pile



Cross-Section of Interlocking Steel Sheet Piling.
The Vanderkloot Steel Sheet Piling Co., 135 Adams St., Chicago.

is first rolled to a form resembling an I-beam, with flanges of unequal length; the two shorter flanges are then forced outwards beyond the longer ones, and by means of special rolls the latter are then bent to the hooked form. The pile is rolled in from 10 to 12 passes. If there is probability of the piles having to be pulled up after use, a hole is punched in the web of each, near the top; but otherwise no work is required beyond the rolling. The piles have an effective width of 12 ins., and for piles having a ⅜-in. or ½-in. thickness of web the weight per square foot of finished wall is 35 and 40 lbs., respectively.

In point of weight this type of pile is claimed to have an important advantage over its competitors. Another advantage claimed for the piling is that the adjacent piles interlock on both sides of the web and are thus held from movement in either direction. The ribs formed by the flanges and the wide contact bearing surfaces of these flanges on both sides of the web serve to stiffen the wall of piling so as to afford great resistance to pressures from either side. At the same time the interlocking at the joint, with a bearing on both sides of the web, is such as to hold each pile in line while being driven, so as to form a straight wall. This system of piling is being introduced by the Vanderkloot Steel Piling Co., 135 Adams St., Chicago, of which Mr. Adrian Vanderkloot is President.

THEORIES TO ACCOUNT FOR THE EXPLOSION OF THE SARATOGA SEPTIC TANK.

The explosion of one of the four septic tanks at Saratoga Springs, N. Y., on Jan. 26, 1906, was briefly noted in our issue of Feb. 15, 1906. A theory to account for the explosion was advanced by Prof. Wm. P. Mason, of Troy, N. Y., at a meeting of the New England Water-Works Association, on Dec. 12. The sewage works of which this tank formed a part was described in our issue of Feb. 2, 1905. Each of the four septic tanks is 51½ × 91½ ft. in plan, has depths of 7¾ and 8¼ ft. at the inlet and outlet ends, respectively, a holding capacity of 250,000 gals., and is covered by groined arches of 11½-ft. span, 2½-ft. rise, with a crown thickness of 6 ins. The walls, roof, columns and inverted arch bottoms of the tanks are of concrete and each tank roof is pierced with six manholes, provided with iron covers.

That the explosion was not due to the malicious introduction of a high explosive (a local theory) was indicated, Professor Mason stated, by the fact that instead of being concentrated at one point it was so distributed as to lift the whole

roof from the side walls and the columns. The roof "probably did not rise over 10 or 15 ft., and then fell back in a state of utter ruin." The "manhole covers were thrown to great heights."

Professor Mason put forth the theory that the "mixture of septic gas and air," between the sewage and the roof of the tank, was ignited by the escape from the sewage of a bubble of phosphine, which burst into flame as it emerged from the sewage. The lesson of the explosion is to so ventilate septic tanks as to prevent the formation of explosive mixtures within them.

Those who discussed the paper agreed in attributing the explosion to some more ordinary cause than phosphine. Prof. L. P. Kinnicutt, of Worcester, Mass., asked why, if phosphine is formed in such a way we are not continually hearing of explosions, not only in septic tanks, but in cesspools and sewers? He was more inclined to think that the explosion had resulted from a match, possibly caught in a manhole cover until burned off and then falling into the tank, or from fire introduced more or less through human agency.

Mr. F. A. Barbour, M. Am. Soc. C. E., of Boston, who built the Saratoga tank and supervised its operation when first put into service, said that his information was that there had been two men about the tank, one of whom was telephoning, and the other had just gotten off the roof of the tank when the explosion occurred. He knew that at least one of these men was a smoker, and he felt that in some more or less direct way he had introduced a match, or possibly glowing ashes from his pipe.

Mr. John A. Gould, of the Boston Consolidated Gas Co., said that the gas companies had found that a glowing cigar or pipe would not ignite an explosive mixture of gas and air, but they prohibited smoking because matches are used in lighting the cigar and pipe.

Mr. Harrison P. Eddy, Assoc. M. Am. Soc. C. E., Superintendent of Sewers, Worcester, Mass., took the same view as Professor Kinnicutt.

THE CIVIL ENGINEER CORPS OF THE U. S. NAVY.

The civil engineer corps of the U. S. Navy has long been known as one of the most poorly paid branches of the government service. The small size of the corps has made conditions such that its members have fallen in rank far below their contemporaries of the line. This was somewhat helped last year when the corps was regarded to the extent of giving the civil engineers below the rank of lieutenant-commander the rank of the line officer who determined their precedence.

The extent to which they had fallen behind the rest of the service in rank is shown by the fact that most of the 18 civil engineers with the rank of lieutenant (junior grade) at once received the rank of lieutenant, and the balance received this rank in a very short period. It is apparent that this relief will only be temporary and that in the near future the corps will again fall behind in rank, as compared with those with whom they now take precedence, and will be constantly passed by younger men in the other corps of the service.

The Chief of the Bureau of Yards and Docks in his report for the fiscal year ending June 30, 1906, says:

> Assistant civil engineers should have the rank of lieutenant and pass to the grade of civil engineer on vacancy or after eight years' service as assistant. During the first ten years' service civil engineers should have the rank of lieutenant-commander, during the second ten years the rank of commander, and after twenty years the rank of captain.
>
> During the year two civil engineers have resigned to accept more attractive positions in civil life, and continued difficulty is experienced in filling the grade of assistant civil engineers from civil life by competitive examination. Three examinations have been held in the past two years for the position of assistant civil engineer without any of the candidates reaching the required standard, and on the last examination but three candidates presented themselves. These conditions are thought to be due to the lack of compensation and advancement which at present exists in the civil engineer corps and the much greater inducements that are offered the young civil engineer in civil life.
>
> Three of the vacancies in the grade of assistant civil engineer have been filled by appointment of graduates of the Naval Academy who failed to pass the high physical standard required for sea service, although they were found physically qualified for the duties of the civil engineer corps. These men are being given a special course of instruction in civil engineering to better fit them for their duties in the same manner that is pursued in the case of assistant naval constructors.
>
> There still remain seven vacancies in the grade of assistant civil engineer, and if provision can be made for rank and pay commensurate with the nature and importance of the duty and comparative with that of the balance of the service it is thought that there will be no difficulty in immediately filling the corps with desirable men.

The examination of candidates for appointment to this corps cover so broad a field that it has become practically impossible to obtain candidates. To pass the theoretical part of the examination, a man must be fresh from college, and, therefore, lacking in the practical experience which is an absolute requirement, or else he must give more time to preparatory study for the examination than engineers of competence and reputation are willing to give. To pass the practical part of the examination, covering as it does details of structural design, masonry and foundations, pavements, waterworks, railways, sewers, wharves, docks, boilers, engines and electrical equipment, requires a versatility not found in men who are willing to accept a position at $1,800 a year with small hope for rapid advancement.

THE AMENDED FORM OF CONTRACT FOR COMPLETING THE PANAMA CANAL.

The new contract for the completion of the Panama Canal, on which bids are to be received until noon of Jan. 12, was made public at Washington on Monday of this week. The original form of contract was published in full in our issue of Oct. 18, and certain changes in the contract were reported in our issue of Nov. 8.

The following is a summary of the more important of the later changes just announced:

QUALIFICATIONS OF BIDDERS.—Bidding is limited to American contractors. Available capital above all debts must be $5,000,000, but in this amount may be included the security required to be given to the bonding company. The bond required is reduced to $2,000,000. The Commission reserves the right to reject all bids, and announces that in case no bid is found satisfactory it will either throw open the bidding to foreign competition or proceed with the work without letting contracts.

PLANT TO BE FURNISHED BY THE COMMISSION.—The necessary work animals and equipment is to be included in this, also water for all purposes required in the prosecution of the work.

THE RESPONSIBILITY OF CONTRACTOR FOR DEFECTIVE WORK.—The clause in the original contract making the contractor responsible for use of unsound materials, or improper preparation or use of material, is modified so that the contractor can protect himself by requiring of the Chief Engineer, in writing, a definite approval of any particular materials or any specified preparation or use thereof. If the contractor so protects himself, cost of replacement of defective materials is paid to the contractor as part of the cost of the canal.

PAYMENTS TO THE CONTRACTOR.—Besides those heretofore specified, there is included transportation of employees whose pay is chargeable against the Commission, to and from the Isthmus, also the cost of procuring labor.

ERRORS IN ESTIMATES BY THE ENGINEERING COMMITTEE.—A new clause is added, to the effect that if the President of the United States shall decide that the Engineering Committee's estimates are based on erroneous physical data, or have become substantially inequitable from any cause not taken into account by that committee and for which the contractor is not responsible, or if the average scale of wages shall vary substantially from that assumed by the Engineering Committee, then the original committee or a new committee formed in the same manner shall convene and modify the estimate as to the cost or time, or both.

DAMAGES AGAINST THE CONTRACTOR.—In case of default by the contractor, the damages for which he may be held liable are limited to the percentage and premiums otherwise payable to him, and $3,000,000 in addition.

TERMINATION OF CONTRACT BY COMMISSION.—The Commission has a right to terminate the contract at any time at its discretion, even though the contractor be not in default, by paying him the entire cost of the work he has done, all the percentage earned by him, and $250,000 additional, and if at the time he has done less than one-third of the whole work, 10% additional. Premiums or deductions for time in advance of or behind the contract date shall also be paid or assessed against him.

THE MEETING OF THE SHIELDS of the fourth tube of the New York Rapid Transit Subway East River Tunnel occurred on Dec. 14. Six days before a 6-in. pipe had been pushed through from shield to shield, as noted in our last issue, and a check of the working lines made. The tunnel is part of the Brooklyn extension of the rapid-transit subway, comprising a two-track subway in the Borough of Manhattan, from Brooklyn Bridge down Park Row and Broadway to the Battery, two single-track tunnels across the East River to Joralemon St., Borough of Brooklyn, and a four-track subway along Joralemon St., Fulton St., Atlantic Ave. and Ocean Ave. to Park Side Ave., Borough of Brooklyn, the total length being about 5½ miles. The section in Manhattan is the only part of the extension in operation, being operated as an integral part of the original New York subway. But the Brooklyn sections are in large part completed, and operation over the whole line can be started as soon as the tunnel is ready for trains. This is expected to be the case by next summer.

THE PENNSYLVANIA 18-HOUR TRAIN between New York and Chicago was wrecked at Canton, Ohio, Dec. 16, while running at high speed. The Pennsylvania tracks cross, at grade, those of the Wheeling & Lake Erie R. R. at this point, and the wreck was caused by a freight train on the latter road trying to cross ahead of the flyer. The freight engine was demolished and the engineer and fireman killed, but no one on the flyer was hurt, although the engine and several cars were derailed. The accident is said to have been due to the engineer of the freight ignoring signals, which were set against him.

A BAD WRECK occurred on the New York Central & Hudson River R. R., at Palmyra, N. Y., Dec. 17. A collision of two local freight trains threw several cars over on to the passenger track and before a flagman could get out to signal an approaching passenger train, it crashed into the wreckage. The passenger train, known as the "Buffalo Local," was drawn by two engines and was running at high speed to make up lost time. The passenger train was ditched and the wreckage immediately took fire, two Pullmans, one day coach, a smoking car, an express car and a baggage car being consumed. No one was killed, but one of the engine runners was seriously injured.

NIAGARA POWER REACHED TORONTO on Dec. 13, 1906, over the lines of the Toronto & Niagara Power Co., distributors for the Electrical Development Company. Two three-phase circuits extend from the latter company's plant at Niagara Falls, Ont., to a 40,000-HP. substation at Toronto. The line-pressure is 60,000 volts. The current will be used for lighting, street railway and power purposes in Toronto.

STREET RAILWAY VALUATION at Chicago has been completed by the city authorities and the railway companies in connection with the long continued controversies as to franchise matters and the proposed purchase of the lines by the city. The city's special commission was composed of Bion T. Arnold and M. E. Cooley, as engineers, and A. B. Dupont as a former manager. In addition to the valuations (given below), the city's commission estimated that to reproduce the two systems in modern style would cost $32,333,000 for the Union Traction Co.'s system (north and west sides), and $23,888,000 for the Chicago City Ry. (south side). The respective valuations under existing conditions are as follows:

	City's estimate.	Company's estimate.
Union Traction Co.:		
Physical property	$18,460,888	$26,578,290
Total (including stores, legal expenses, etc.)	23,362,746	32,873,683
Chicago City Ry. Co.:		
Physical property	14,735,239	18,300,122
Total (including stores, legal expenses, etc.)	18,614,705	20,806,400

PLANS FOR THE $6,000,000 BATTLESHIP authorized at the last session of Congress were transmitted to the present session of that body Dec. 13, by Secretary of the Navy Bonaparte. The design selected by the Special Board, of which Assistant Secretary of the Navy Newberry was President, was submitted by the Bureau of Construction of the Navy. The new ship will have a displacement of 20,000 tons; length at water line, 510 ft.; extreme breadth, 85 ft. 2⅝ ins.; mean draught, 27 ft. and a bunker capacity of 2,300 tons. Her main battery

will consist of ten 12-in. breech-loading rifles, while her secondary battery will have fourteen 5-in. rapid fire guns, four 3-pounder saluting guns, four 1-pounder semi-automatic guns, two 3-in. field pieces, two 0.30 calibre machine guns and two submerged torpedo tubes. Boilers, machinery and magazines will be protected by a water-line belt of armor 8 ft. wide, with a maximum thickness of 11 ins. Above this main belt will be placed a second belt, with a maximum thickness of 10 ins., while the major portion of the secondary battery and bridge structure will be protected by 5-in. armor. The type of engines to be used has not, as yet, been decided upon, provision having been made for either reciprocating engines or turbines. Her speed will be 21 knots per hour.

CAR SHORTAGE THROUGHOUT THE UNITED States is to be investigated at once by the Interstate Commerce Commission. It is expected the first hearings will be held in the Northwest with relation to the shipments of wheat. There are, however, millions of tons of freight awaiting shipment at the present time in the United States which the railway companies confess they are unable to handle promptly. Whether this is due to car shortage or to the manner in which cars are handled is a matter to be determined. The Commission already has representatives in the Northwest making investigations, but it is desired that all who have complaint to make regarding shortage of facilities and equipment should make such complaint known to the Commission by letter or by telegram. Specific information is desired on the following questions:

1. What amount of freight has been offered for shipment at your station which the railways have not hauled, and what reason is given for not transporting the same?
2. Are empty cars allowed to remain upon side-tracks or in yards for any length of time?
3. Are loaded cars held an unusual length of time before being hauled to destination?
4. Is it the policy of the railroads as shown by their practice to make use only of the large cars of recent construction and abandon the use of the older and smaller cars?
5. Has any industry or any commodity difficulties in securing supply of cars not suffered by other industries or commodities?

THE CAPE COD SHIP CANAL PROJECT has been taken up by August Belmont, of New York, and a new attempt will be made to enlist capital for the work. Mr. Wm. Barclay Parsons has been made Chief Engineer of the company and it is stated that the New York, New Haven & Hartford R. R. Co. is friendly to the enterprise. The project is a very old one, having been agitated in a more or less desultory way for fully two centuries. As far back as 1697, the General Court of Massachusetts ordered an inspection to be made of the proposed location; and in 1776 Thomas Machin made a survey for the General Court. He proposed a channel 14 ft. deep, requiring an excavation of 982,000 cu. yds. and involving an estimated expenditure of £32,148. Later surveys were made in 1791 and in 1818, the latter by Loammi Baldwin; and in 1825 a survey was made by United States Engineers. From 1830 to 1860 the project slumbered, but was renewed in the latter year, when a full report on the work was made by a joint committee of the Massachusetts Legislature. The outbreak of the Civil War, however, diverted attention from the enterprise and later the development of railway transportation facilities diverted attention from the subject of waterways. Spasmodic attempts to revive it have been made at various times during the past twenty years; but all without result.

A 65-MILE ELECTRIC INTERURBAN RAILWAY will soon parallel the steam road connecting the cities of Dallas and Sherman in Texas. Power for the new road will be obtained from Curtis steam turbo-generators located in a station about midway between the two cities. Three-phase current will be generated at 2,200 volts and stepped up to 19,100 volts for transmission. The special feature of interest in the new road is the rotary converter equipment. Six substations will be provided, including one at the main station and a portable equipment. The portable substation comprises a special car containing a 300-KW. rotary converter, air-blast transformers, and suitable switching apparatus for cutting into the transmission system whenever necessary. The portable substation renders unnecessary the duplication of rotary converters at the fixed substations, for the portable equipment can be shifted to various parts of the line and used as an emergency station or auxiliary in case of need. With but few exceptions the new line, contracts for which have been let by the Texas Traction Co., follows the standard direct-current practice of the General Electric Co.

BASINS AT THE HEAD OF THE PANAMA CANAL locks, which have been proposed as a safeguard in case of possible carrying away of the lock gates, have now been abandoned. At a meeting in the Canal Zone, Nov. 15, 1906, the Isthmian Canal Commission adopted the following resolution:

Whereas: Under resolution of the Commission at its meeting held Sept. 16, 1906, the Chief Engineer was "requested to consider the advisability and practicability of constructing a basin with walls and gates at the head of each lock, or flight of locks, in which basin the lake level will be maintained and all vessels stopped before entering the chamber of the lock and furnish the Commission with his recommendations and estimate of the cost of the same," and

Whereas: The Chief Engineer pursuant to such request, under date of Nov. 5, reported that after careful consideration the estimated cost of such basins would aggregate $9,971,000, and that in his opinion the increased insurance by constructing the guard basins will be too small to offset the decreased efficiency of the Canal, for which reason he recommends that the proposed addition of these basins to the upper locks be omitted from the Canal plans, but that safety gates be installed; now, therefore, be it

Resolved: That the Commission concurs in the recommendations of the Chief Engineer and that the proposed addition of these basins to the upper locks be omitted from the Canal plans, but that safety gates be installed.

THE HARBOR WORKS AT DOVER, ENGLAND, now approaching completion, will form a harbor covering 775 acres, of which 700 acres will be for naval purposes. There will be two entrances, that on the west 800 ft. wide and that on the east 600 ft. wide. The commercial harbor, covering 75 acres, has two great concrete piers. On one side is the Admiralty Pier, which is to be 4,000 ft. long; for 2,000 ft. from the shore it will be 350 ft. wide, with a great terminal station for passengers of the channel steamers and transatlantic liners. Beyond this, the pier will be about 50 ft. wide for a distance of 2,000 ft. On the other side of the commercial harbor is the Prince of Wales Pier, 3,000 ft. long. In addition to the harbor works proper, extensive military defence works are being built, all this work being done at the cost of the Harbor Commission of Dover. Sir Geo. Coote & Son are the Consulting Engineers, and E. J. Pearson & Son are the contractors.

PERSONALS.

Mr. W. A. Lathrop has been elected Manager of the Lehigh Coal & Navigation Co., to succeed Mr. Lewis A. Riley.

Mr. Charles F. Shelton has resigned as Superintendent of Transportation of the Fort Wayne & Wabash Valley Traction Co.

Mr. M. H. Blivins has been appointed Superintendent of the Niagara Falls Water Works Co., to succeed Mr. J. H. Ince, resigned.

Mr. J. W. Cable, of Toledo, Ohio, has been appointed Secretary of the State Board of Public Works, to succeed Captain William E. Thompson, resigned.

Capt. J. F. Le Baron, M. Am. Soc. C. E., has been appointed President of a Commission to study and report on the hydro-electric powers of Nicaragua, C. A.

Mr. Felix M. Williams has been promoted from Commercial Agent for the Texas & Pacific Ry., at Shreveport, La., to Superintendent of Terminals at New Orleans, La.

Mr. Frank Waters has been appointed General Manager of the Chicago & Northwestern Ry. Lines West of the Missouri River, to succeed Mr. G. F. W. Bidwell, resigned.

Mr. J. B. Ingersoll has been promoted from Assistant Manager and Chief Engineer of the Spokane & Inland Ry., to General Manager of the road, and also the Spokane Terminal Co.

Mr. Arthur R. Briggs, Secretary of the State Board of Trade of California, has been elected President of the California Water and Forest Association. Mr. T. C. Friedlander is Secretary.

Mr. John Howard Alexander, formerly Engineer with the Hamilton Bridge Co., Hamilton, Ont., has accepted the position of Concrete Engineer of The General Fireproofing Co., of Youngstown, Ohio.

Mr. John V. Hanna, Assistant Engineer of Maintenance of Way, St. Louis & San Francisco R. R., at St. Louis, Mo., has resigned and accepted the position of Chief Engineer of the Kansas City Terminal Ry.

Mr. Geo. F. Syme, formerly Locating Engineer of the Santa Cruz Co. at Patagonia, Ariz., has been appointed Assistant Engineer of the Cananea, Rio Yaqui & Pacific Ry. His address is Cananea, Sonora, Mexico.

Mr. John M. Culp has been appointed Second Vice-President; Mr. Charles H. Ackert, Third Vice-President; Mr. Thomas C. Powell, Fourth Vice-President, and Mr. Henry B. Spencer, Fifth Vice-President of the Southern Ry.

Mr. J. W. Small has been appointed Superintendent of Motive Power of the Arizona Eastern R. R., the Arizona & Colorado R. R., the Cananea, Yaqui River & Pacific R. R., the Maricopa, Phoenix & Salt River Valley R. R. and the Gila Valley, Globe & Northern Ry., with headquarters at Tucson, Ariz.

Mr. W. W. Gaffin has been appointed Division Engineer of the Northern Wisconsin and Lake Shore Divisions of the Chicago & Northwestern Ry., with office at North Fond du Lac, Wis. Mr. Wm. Sweeney has been appointed Foreman of Bridges and Buildings for the same divisions.

Mr. Frank G. Baum, M. Am. Inst. E. E., for the past three years connected with the California Gas & Electric Co. of San Francisco, has resigned his position, effective Jan. 1. He will open offices in the Chronicle Building, San Francisco, Cal., as a Consulting Engineer, giving special attention to hydro-electric power plants and long distance transmission systems.

Mr. W. M. Macphail, Assoc. M. Can. Soc. C. E., Roadways Engineer of Toronto, Ont., has resigned to accept the position of Vice-President and General Manager of the Bituilthic & Contracting Co., Ltd. This company is incorporated in the Province of Manitoba to carry on a paving and general contracting business under the rights and patents of The Warren Bros. Co. of Boston, Mass. The main office will be at Winnipeg, with branches at St. Boniface, Man., Regina, Sask., and Edmonton, Alberta.

Mr. Cornelius C. F. Bent, General Superintendent of the Baltimore & Ohio, R. R., has been elected Vice-President and General Manager of the Baltimore & Ohio Southwestern R. R., to succeed Mr. Wm. M. Greene. Mr. Bent began his railroad career as a chainman on the Lake Superior & Mississippi R. R. in 1867. He went with the Pennsylvania Railroad in 1875 as Assistant Supervisor, becoming Supervisor in 1876, and was connected with the Pittsburg, Cincinnati & St. Louis R. R. from 1879 to 1882, first as Assistant Engineer, then Superintendent. From 1885 to 1894 he was General Superintendent of the Ohio & Mississippi R. R. He became connected with the Baltimore & Ohio R. R. in 1895, and has held the positions of Superintendent and General Superintendent of several divisions of the road. About 1½ years ago he became General Superintendent of the whole road.

Obituary.

John Sellers, Jr., Vice-President of the Edgemoor Iron Co., and Vice-President and Treasurer of William Sellers & Co., Iron Founders, died Dec. 14, at his home in Philadelphia, Pa., aged 80 years.

Rufus W. Gillett, President of the Detroit Copper & Brass Rolling Mills, died Dec. 14 at his home in Detroit, Mich., of heart disease. He was born at Torrington, Conn., April 22, 1825, and had been president of the above firm since 1894.

James Hughes, a member of the firm of Hughes Bros. & Bangs, one of the largest firms engaged in contract work on the Government River and Harbor improvements, dropped dead at Cleveland, Ohio, Dec. 12, of heart disease, aged 52 years. He was a former resident of Syracuse, N. Y., but had lived in Cleveland for the last seven years.

Col. John J. Pride, Volunteer Aid and Chief Engineer for General Grant in the Fort Donelson, Shiloh and Vicksburg campaigns of the Civil War, dropped dead at Huntington, Ind., Dec. 11. He was the last surviving member of the personal staff of General Grant.

Gen. John M. Hood, President of the United Railways & Electric Co. of Baltimore, Md., died in that city Dec. 17, aged 63 years. General Hood served in the Confederate army during the Civil War, afterwards taking up railway work. In 1874 he was elected President of the Western Maryland R. R., and remained at its head for 28 years, when he resigned. He was elected President of the United Railways & Electric Co. in 1902.

Wallace Clyde Johnson, Consulting Engineer of the Niagara Falls Hydraulic Power & Mfg. Co. and Chief Engineer of the Shawinigan Water & Power Co., died at his home in Niagara Falls, N. Y., Dec. 15, aged 50 years. He was born at Granville, Mass., and was a graduate of Williams College and Worcester Polytechnic Institute. Mr. Johnson was a member of the River Improvement Commission of the State of New York, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and an associate member of the American Institute of Electrical Engineers. He had been connected with the Niagara Falls company for the last 20 years.

Fitzhugh Townsend, Assoc. M. Am. Inst. E. E., a consulting engineer of New York City, and Instructor in the Electrical Engineering Department of Columbia University, died at New York City Dec. 11, of typhoid fever, aged 35 years. He was a graduate of Columbia, receiving the degrees of Bachelor of Arts in 1893 and Electrical Engineer in 1896. He had been connected with the university since 1899, first as tutor, then as instructor. Mr. Townsend was the inventor of the electrical signal device, which the General Railway Signal Co. is now installing in the electric zone of the New York Central & Hudson River R. R. and the New York, New Haven & Hartford R. R. He was the joint author with Prof. George F. Sever of "Laboratory and Factory Tests in Electrical Engineering."

James S. Coleman, a well-known contractor of New York City, died at his home in New York Dec. 16, aged 63 years. He was a graduate of the College of the City of New York, and for the last 40 years had been en-

gaged in contracting work. In 1863 he and his brother, Michael S. Coleman, undertook contract work and secured the contract for the bridge, masonry and grading of the Texas & Pacific Ry., besides construction work on other roads. Later they built the Weehawken tunnel and other portions of the West Shore R. R. In 1892 he secured the contract for the new Croton dam, but assigned the contract in 1895 to Coleman, Ryan & Brown, who in 1899 assigned it to Coleman, Breuchaud & Coleman. Mr. Coleman was the senior member of both of these firms. From 1881 to 1889 he acted as Street Cleaning Commissioner of New York City, and organized the present Department of Street Cleaning.

Col. John Mercer Brooke, Emeritus Professor of Physics at the Virginia Military Institute, died at his home in Lexington, Va., Dec. 14, aged 80 years. Colonel Brooke was born at Tampa, Fla., Dec. 18, 1826, and entered the U. S. Navy in 1841 as a midshipman. Later he entered Annapolis and was graduated from the Academy in 1847 with the first class that left the institution. From 1851 to 1853 he was stationed at the Naval Observatory at Washington, and while there invented a deep-sea sounding apparatus that enabled scientists to ascertain the nature of the ocean's bed. He had charge of the astronomical department of the North Pacific surveying and exploring expedition under Commodore John Rogers, and commanded the expedition that surveyed the route between San Francisco, Sandwich Islands, Japan and China. He resigned from the U. S. Navy in 1861 on the secession of Virginia and entered the Confederate navy. He was made Professor of Physics at the Virginia Military Institute in 1866 and was elected Emeritus in 1889. Colonel Brooke was the inventor of the Brooke gun and other munitions of war. He reconstructed the "Merrimac" with a ram, and iron covering of steel rails, this being done according to his own plans.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN ECONOMIC ASSOCIATION.
Dec. 26-28. Nineteenth Annual Meeting at Providence, R. I. Secy., Mr. Winthrop M. Daniels, Princeton, N. J.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 2, '07. Annual Meeting at New York City. Secy., L. O. Howard, Cosmos Club, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 3. Annual Meeting at Pittsburg, Pa. Secy., F. V. McMullin, 410 Pennsylvania Ave., Pittsburg, Pa.

THE AMERICAN INSTITUTE OF ARCHITECTS.
Jan. 7-9. Annual Convention at Washington, D. C., Secy., Glenn Brown, Washington, D. C.

MICHIGAN ENGINEERING SOCIETY.
Jan. 8. Annual Convention at Detroit, Mich. Secy., F. Hodgman, Climax, Mich.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 8-11. Annual Meeting at Chicago, Ill. Secy., W. W. Curtis, 585 Caxton Bldg., Chicago, Ill.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 9. Annual Meeting at Boston, Mass. Secy., Mr. Willard Kent, Narragansett Pier, R. I.

IOWA ENGINEERING SOCIETY.
Jan. 9-11. Annual convention at Ottumwa, Ia. Secy., A. W. Ford, Iowa City, Ia.

WOOD PRESERVERS' ASSOCIATION.
Jan. 15. Annual Meeting at Memphis, Tenn. Secy., C. W. Berry, Laramie, Wyo.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 16-17. Annual Meeting at New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Jan. 16-18. Annual Convention at St. Paul, Minn. Secy., Martin T. Roche, 410 Pioneer Press Bldg., St. Paul, Minn.

INDIANA ENGINEERING SOCIETY.
Jan. 17-19. Annual Meeting at Indianapolis. Secy., C. C. Brown, Commercial Club Building, Indianapolis, Ind.

THE ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 19. Annual Meeting at Philadelphia. Secy., Walter Loring Webb, 1122 Girard St., Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 22-24. Annual Meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 23-25. Annual Meeting at Peoria, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 29. Annual Meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal, Quebec.

THE NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 4-16. National Convention at St. Louis, Mo. Secy., Theo. A. Randall, Indianapolis, Ind.

NEW ENGLAND GAS ASSOCIATION.
Feb. 21. Annual Meeting at Boston, Mass. Secy., N. W. Gifford, East Boston, Mass.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 26. Annual Meeting at Toronto. Secy., Killaly Gamble, 405 Temple Bldg., Toronto, Ont.

OKLAHOMA ENGINEERS' AND SURVEYORS' SOCIETY.—This society was organized at Oklahoma City, Okla., Dec. 5. Prof. D. E. Chandler, of Stillwater, Okla., was chosen President; Mr. H. V. Hinkley, of Sulphur, Ind. T., First Vice-President; Mr. D. B. Merry, of Cleveland, Okla., Second Vice-President, and Mr. J. E. Janske, of Norman, Okla., Secretary and Treasurer. The Executive Committee is composed of the officers of the society.

WESTERN SOCIETY OF ENGINEERS.—The proposition to increase the subscription fees and dues has been submitted to letter ballot and carried by a large majority, over 77% of the votes cast being in favor of the change. Beginning with the new year, 1907, the annual dues will be $12.50 for resident active and associate members, $8.50 for non-resident active and associate members, and $5 for juniors. This last amount remains unchanged, the increase being for members and associate members.

At the meeting of the electrical section on Dec. 21, Mr. R. F. Schuchardt will present a paper on "The Rotary Converter Sub-station." The annual meeting will be held Jan. 8.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The Annual meeting of the society will be held at Pittsburg, Pa., Jan. 3 at 8 p. m. The officers nominated are as follows: President, Mr. S. M. Kintner; Vice-President, Mr. George T. Barnsby; Treasurer, Mr. A. E. Frost; Secretary, Mr. Edmund Yardley; Directors, Messrs. R. A. Cummings, Walter Riddle, F. Z. Schellenberg and J. O. Handy. The annual banquet will be held at Hotel Schenley, Saturday evening, Jan. 12. At a special meeting held Nov. 26, the amended Charter as presented at a previous meeting, was approved and ordered to be presented to the Courts. The amended By-Laws were referred back to the Board of Direction with instructions to have them rewritten.

THE ENGINEERS' CLUB OF CENTRAL PENNSYLVANIA.—The annual election of the club was held Dec. 7, and resulted as follows: President, Mr. Thomas Earle; First Vice-President, Mr. L. H. Kinnard; Second Vice-President, Mr. T. R. Crowell; Secretary and Treasurer, Mr. I. C. Lewis; Directors, Messrs. W. B. McCaleb and D. R. Tracey. A paper by Mr. J. H. Fuertes, of New York City, on "Purification of Water by Filtration and the Limitations of the Different Processes," was read by the author. On Saturday afternoon, Dec. 8, a party composed of members of the club visited the Harrisburg Filtration Plant on Independence Island. They were conducted by Mr. Fuertes, who is Consulting Hydraulic Engineer for the City of Harrisburg, Pa.

NORWEGIAN-DANISH TECHNICAL SOCIETY OF NEW YORK.—A preliminary meeting, for discussing the formation of a Norwegian and Danish engineering society, was held at the Eastern Hotel, New York City, Dec. 1. A committee was appointed to prepare constitution and by-laws and offer suggestions for a name for the society. This committee reported at a meeting held Dec. 8, when the above name was adopted and the constitution and by-laws discussed. The object of the society is the promotion of technical science and social good-fellowship among its members. Meetings will be held twice a month. A cordial invitation is extended to all Danish and Norwegian technical men to join the society. Mr. E. Mackenzie, 551 45th St., Brooklyn, N. Y., is President, and Mr. A. Odlang, 151 Congress St., Brooklyn, Secretary.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.—On Dec. 15 through the kindness of the officials of the New York, New Haven & Hartford R. R. Co. the society made an inspection trip of the improvements along this railroad from New York to New Rochelle. The party, numbering about 100, left the Willis Ave. Station on a special train at 1.30 p. m.

The first stop was made at the 135th St. concrete plant of the N. Y. Contracting Co., which is putting in a line of elevated construction with concrete abutments at this point. The plant consists of two nominal 1-yd. Smith mixers mounted on a platform some 50 ft. above the level of the ground and supplied with sand and stone by an endless bucket carrier. From this platform the finished concrete is carried by dinky train to places of work within a radius of two blocks.

At the Bronx River the new temporary drawbridge was inspected. This bridge, which is to carry traffic for about two years until the widening of the roadbed and enlarging of the main line is accomplished, is a bob-tail swing bridge affording a free-waterway 75 ft. in width. The main girders are of the lattice type made up principally of 80-ft. Oregon fir sticks. The overhang of the bridge when open is offset by counterweights connected to 3-in. round rods running over towers on the abutments to the far end of the moving part.

The next stop was at Hutchinson River, a branch of Pelham Bay. At this point a bridge was started some years ago and the masonry piers were finished. These piers do not fit into the new scheme and are to be removed. Preparations are being made for a 6-track Scherzer rolling lift here.

The final point of interest was New Rochelle, where the catenary system of overhead electric transmission for single-phase traction is being installed on the main lines of the railway. The bents carrying the wires here are about 300 ft. apart, requiring a remarkably heavy construction. A similar construction was described in Engineering News, Vol. 53, p. 362.

ILLUMINATING ENGINEERING SOCIETY.—The December meeting of the New York Section of this society was held in the Edison Auditorium, 44 West 24th St., New York City, on Friday, Dec. 14, 1906. The meeting was called to order at 8.30 p. m. by Mr. C. H. Sharp, acting as president, Mr. L. B. Marks being absent. About 50 were present to hear Dr. C. P. Steinmetz deliver an address on "Light and Illumination." He first discussed light waves of different frequencies and then considered the measurements of different colored lights by means of comparison. He claimed that for colored lights a fairly accurate comparison of their intensities could be made by measuring the distances from each light at which it is possible to read; this method, although not as accurate as photometric comparison, because eyes vary somewhat in their sensibility to different colors, answers well as an approximate method. By increasing the incandescence of a body its temperature increases, but as the temperature is limited by the amount which the body will stand without being destroyed, the problem is to find the materials that can stand the higher temperatures. Carbon as used in the arc lamp is one of the best materials thus far found. The speaker said that illumination rather than light was the point to be considered by illuminating engineers, and he discussed the former from the standpoints of general illumination and local or concentrated illumination. For securing very effective illumination the shade of color used is very important. For machine shops, for example, the orange yellow light of incandescent lamps is best, whereas for outdoor illumination where there is vegetation, the light of the arc lamp is decidedly best. In closing, he differentiated between direct illumination and indirect illumination, also between diffused light and direct light. In the discussion which followed, Mr. V. R. Lansingh, in speaking of the disadvantages of shadows in lighting, said that if a shadow is but 20% of the surrounding illumination it is not objectionable, but if more than this it is very objectionable. He claimed that both quantity and intensity of light affect the eyes and should be studied together in any lighting problem.

AMERICAN ELECTROCHEMICAL SOCIETY. — The New York Section of this society held a meeting Tuesday evening, Dec. 11, at the Chemists' Club, 108 West 55th St., New York City. There were 83 in attendance, and much interest was shown in the proceedings which lasted from 8.30 until 11.30 p. m. The retiring chairman, Prof. Charles A. Doremus, of New York City, opened the meeting with a brief address in which he outlined the work of the society since its formation in September, 1903. He said that the formation of the American Electrochemical Society had been the means of inducing chemists in England to form the Faraday Society. The secretary and treasurer, Mr. Alois Von Isakovics, of Monticello, N. Y., stated in his report that the society now had in all 300 members, of which there are 86 active ones within 50 miles of the New York City Hall. No attempt had been made to hold monthly meetings, but at those which had been held in New York there had never been less than 50 in attendance. He said if more papers were forthcoming more meetings would be held. The balance on hand was given as $111.16. Motions were adopted to have a committee appointed for making plans as regards assessments and voluntary contributions, and also to select some one publication as the recognized organ of the society. Prof. Samuel A. Tucker was then elected as the new chairman, and Mr. Alois Von Isakovics was re-elected as secretary and treasurer. Mr. Van Rensselaer Lansing next gave an informal yet exceedingly interesting and instructive discussion of the problem of illumination from the standpoint of the illuminating engineer. He treated the subject from the economical, physiological, and artistic standpoints, and confined his remarks to the different forms of electric lamps. Among the principal points brought out was (1) the flickering of lamps on alternating-current circuits of low frequency, (2) the action of the smooth reflecting inside surface of porcelain shades which intensifies the streaks resulting from reflections of the filament from the bulb and often ruins the eyes, (3) the mounting of bare lamps in the line of vision, (4) of placing lamps so that the light strikes the eye at unusual angles, and (5) having too deep contrasts between desk lights and the general illumination of a room. As a remedy for (1) lighting should not be attempted on circuits of less than 60 cycles frequency; for (2) lamps with frosted bulbs should be used with the reflectors; for (3) shading the lamps; for (4) mounting the lamp so there is no direct reflection from below the eye; and for (5) increasing the general illumination of a room over that usually employed. Mr. Lansingh's remarks were discussed by Dr. A. H. Elliott, Mr. W. J. Hammer, and others. Mr. Hammer described some interesting experiments he had been conducting for several years past with the object of obtaining light without heat from coal and other substances. He said engineers and scientists would not long be contented with obtaining but 1 or 2% of the energy contained in coal, as light. He predicted that carbon filament and tantalum lamps would be relegated to the scrap-heap, but admitted that tungsten lamps and Moore tubes seemed to present a more promising future.